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Editorial Notes

Prestressed Structural Steel: The Preflex Beam

Prestressed concrete which has become almost a commonplace in recent years has provided structural engineers not only with a new design technique but with an entirely new working material. As a means of overcoming the inherent disabilities of concrete prestressing has undoubtedly opened up a freer and a wider range of possibilities for reinforced concrete structures. In the circumstances, perhaps, it is not altogether surprising that sometimes it has been looked on as a panacea and employed unreasonably in situations where it is not altogether appropriate or where simpler construction methods might have proved more economical. Prestressing techniques are not of course exclusive to the constructional industry. It was long recognised by aeronautical engineers, for example, that a tension member could function as a strut until its initial tension was removed and, conversely, with members constrained to be in compression. Designers in reinforced concrete, working more often than not with indeterminate structures and with two materials having quite dissimilar properties, must combine the effects in one frame member and therein lies the principal difficulty which calls for the exercise of a highly skilled judgment.

It is with more than usual interest therefore that we print in this issue an article which describes what is indeed a new approach to the subject, a process of prestressing structural steel joists first developed in Belgium ten years ago and which is now coming into general use. The principle is extremely simple. A high-tensile steel H-beam is subjected to simple bending to a pre-determined deflection within the elastic limit representing its working load in the structure and whilst in the strained position high-quality concrete is cast around the tension flange. The degree of prestress is therefore precisely known and when the beam is released from its external restraint the elastic recovery induces the exact counterpart compressional strain in the surrounding concrete at every point in the transverse section. When loaded in the structure, therefore, the concrete complements the steel ideally so that increased stiffness results with less risk of cracking, with a better resistance to fatigue than with the more usual prestressing devices. Along with the cased pile, it may well prove to be one of the most significant developments in reinforced concrete design during the past decade and, now that arrangements have been made for the manufacture of what is known as the Preflex beam in the United Kingdom, engineers here will find as wide a field for its application as their counterparts on the Continent have already done. It should have an immediate appeal to those engaged in maritime engineering not only for improving the durability of concrete structures in the neighbourhood of the tidal range but in situations where, for example, bored piles have to be used with correspondingly wider deck spans than are strictly economic in orthodox designs. The new beam should provide a better balance between the two.

The work at Ostend which the article describes furnishes a good example of what can be achieved in that direction. In the reconstruction of this quay the freeboard was low and the tidal range small so that maintenance access beneath the apron was precluded. Additionally, the engineers were committed, practically, to an existing arrangement of foundation piles. From the standpoint of construction the conditions imposed many difficulties and the manner in which they were circumvented reflects much credit on those who were concerned. In more usual circumstances, the prefabricated trestles could doubtless be eliminated but we confess to liking them.

Looking to the future it seems probable that likely developments in wharf working methods will call for wider uncluttered spaces with less emphasis on shed accommodation. Simpler more economical, yet durable, open-work structures and suspended floors capable of withstanding heavy wheel loads at any point are clearly indicated. The Preflex beam system and the newer piling methods can make a big contribution towards this. The real problem is in deciding what is to be done in the transitional period which will accommodate the old methods without impeding the introduction of the new.

Currents Produced by an Air Curtain in Deep Water

We are privileged to present in this issue an account of full scale experiments on the generation of surface currents by underwater discharge of air. The investigation was made for the War Department by Dr. P. S. Bulson of M.E.X.E. and his report reaches conclusions of scientific interest and practical importance. These conclusions are significant in themselves and also because with them we reach another milestone in the investigation of the pneumatic breakwater.

With the publication in 1955 of Sir Geoffrey Taylor's paper on his mathematical study of the effect of shallow surface currents on waves and Mr. J. T. Evans' paper on his experimental study of the same problem it became clear that the dominant factor in wave stopping was the shallow surface current rather than the curtain of bubbles. There remained the big question whether the amount of air required at full scale could safely be deduced from the model experiments. It was not possible to give more than a rough estimate of this without full scale trials. That next part of the investigation has now been completed by Dr. Bulson.

To help Dr. Bulson in this work the Port of Southampton were good enough to place at his disposal a large dock giving a depth of 36-ft. over a width of 102-ft. Air was delivered by a Nene jet engine fitted with a silencer and preliminary trials were made at Harlow by the British Hydromechanics Research Association to ascertain the best way of disposing the pipes and the holes in them

to achieve the most effective mixing of the air with the water. All the preparatory work was done and the equipment assembled at very great speed during the summer of 1960 and the whole experimental programme was crowded into the only fortnight in which the dock would be available.

The report describes in great detail the exhaustive programme of tests that were carried out to find the relationship between the discharge of air and the speed and thickness of the surface horizontal current. The speed and thickness of the vertical current of mixed air and water rising from the pipes to the surface were also examined and new knowledge was obtained about what was going on under the water.

The results show that the efficiency of transforming the power in the compressed air into power in the surface current varies from 10% when the air is discharged 8½-ft. below the water surface to 6% when the air is discharged 34-ft. below the surface. These efficiencies are rather lower than those estimated roughly in 1955 but they are not so low as to be impracticable for some applications.

As Dr. Bulson points out in his valuable report, the need now is to take the next step and perform large scale experiments on waves with very careful instrumentation to find out what the effect is. A few marine experiments made in Japan by Professor Kurihara give some indication that turbulence under the surface current may contribute to the wave breaking.

It is to be hoped that in the not too distant future this next stage may be reached and with it the complete solution of this problem which has worried maritime engineers for the last half century.

Cargo Handling Conference in London

A successful two-day conference on the "Co-ordination of new general cargo handling developments in the British transport industry" organised by the U.K. National Committee of the International Cargo Handling Co-ordination Association was held in London early this month. The good attendance at the conference and the increasing membership of the Association indicate the growing importance of I.C.H.C.A. as an international body and encourage the hope that there is growing awareness of the need for a central research body to consider problems of transportation and of cargo handling at ports. If the port industry is ever going to shake off the out-moded ideas of the 19th century it will be done only by some high-level non-partisan approach and by the careful study of such subjects as the marking of cargo, the simplification of documentation and of the present cumbersome rate structures, the improvement of cargo handling methods, the implications of mechanisation, the manpower problem and the antiquated practice of tallying—a matter discussed at some length on a following page in this issue.

This need for more research was emphasised by Lord Shackleton of Burley who opened the Conference. It was, he said, essential to take the whole question of cargo handling very seriously and it was very necessary that everyone should make an effort to stimulate advances. There was scope for enquiries in a number of directions and there was the need for long-term research going along parallel with such enquiries. Even so, he felt the best solution to the problems must be found through holding conferences where people in the industry could meet and exchange information.

The manpower problem was referred to by Mr. A. J. M. M. Crichton, chairman of the National Association of Port Employers, who was the principal speaker at the Conference dinner. He said that the object of industry must be to use less labour—not for the sake of a reduction in the labour force but because there is not enough labour to go round. The question was not confined to finding manpower, but to applying it. A more balanced labour force was highly desirable in the docks industry and would unquestionably assist the solution of many difficulties. Perhaps it would never be possible to eliminate entirely the basic root of all evil in the docks—the element of casual employment. However, if there could be introduced a greater measure of sensible and practicable mechanical handling, combined with reduced manpower, it would be possible to offer a combination of increased efficiency with higher wages for the men. This did not mean redundancy. The age content in the docks was high, and the employers had succeeded at long last in introducing compulsory retirement, linked very properly with a pension scheme. This meant that the port employers were in altogether a stronger position to control the outflow and, therefore, the intake of men in the industry. The majority of workers were a great deal more intelligent than they were sometimes given credit for; and, if a determined and intelligent lead was given, employers might be surprised at the response.

The next speaker, Mr. F. H. Cave, until recently general manager of the Port of Liverpool, suggested that it was worth considering whether it will ever be possible to have a trained and happy labour relationship unless employees and employers are brought together so that employers know their men and men know their employers. He also referred to the position that had arisen regarding the employment of casual labour in the docks and made the pertinent observation that "nobody thinks it at all strange that at Christmas time the Post Office takes on extra outside workers, but in the dock industry, where employment of casual labour is provided for in the scheme, it is frowned upon. It does not seem to me to make sense."

In his closing speech and summary of the Conference, Mr. J. S. Lloyd, chairman, said that the Papers and discussions showed the value of the interchange of information, and the scope of this could be immeasurably widened and should be encouraged. This was demonstrated by some figures in a publication issued by the Insurance Company of North America. "These figures are unique and illustrate just how great the scope for an exchange of information of this kind has become. The Company distinguishes five major causes of loss and publishes the percentage of all losses under each of these headings for three periods of five years." The results for the past five years are as follows:

Marine perils, sea water and heavy weather ...	5%
Water damage (fresh water and sweat)	13%
Sinkings, strandings, fires, collisions	20%
Theft, pilferage and non-delivery	21%
Handling and stowage	41%

There is no doubt from this analysis where the greatest opportunity for improvement lies.

Ports Inquiry Committee

The Minister of Transport recently announced the membership of the committee appointed, under the chairmanship of Lord Rochdale, to inquire into the major docks and harbours of Great Britain. The other members will be Mr. J. Maurice Laing, managing director of John Laing and Son, Ltd., Mr. Ian W. Macdonald, chairman National Commercial Bank of Scotland, Mr. E. G. Whittaker, transport adviser to Unilever, Ltd., and Mr. Richard Wills, managing director of George Wills and Sons, Ltd. The committee will have the advice of Sir Eric Millbourn, honorary adviser to the Minister on shipping in port.

The committee will shortly be inviting interested organisations, including those representing port authorities, port users, port employers and port labour, to furnish them with any information and observations which may be of assistance to them in carrying out their inquiry. Communications should be addressed to the secretary to the committee, Mr. D. G. Fagan, St. Christopher House, Southwark Street, London, S.E.1.

Berthing Quay at the Port of Ostend

New Technique Reduces Construction Costs

(Specially Contributed)

Introduction

A beam of new design, known as Preflex, was recently introduced into the United Kingdom by the Boulton and Paul Group. The new beam utilizes high-tensile steel and high grade factory concrete to provide a high load bearing capacity on a greater range of span to depth ratios than has previously been economically possible.

For many years, structural engineers have used high-tensile steel, but the span to depth ratios possible have been limited. Similarly pre-stressed concrete has been employed to advantage in many types of structure, but has not necessarily been found to be the best solution where a high load bearing capacity was required or where rigidity had to be combined with a low construction depth in large spans. Furthermore, while it is possible to stiffen a steel joist with an ordinary concrete casing, it has often been found that when such a beam is loaded to its working stress the concrete around the tension flange becomes tensioned with the steel, loses its stiffening value, and in many cases is subject to severe cracking.

During the manufacture of the new type of beam, the steel joists are preflexed to take up a similar curvature to that produced by their full working load, the following being an outline of the process. Two joists are clamped together at quarter points, one about 18-in. above the other, and the ends are pulled together with hydraulic jacks and sling bolts. Whilst held in this position the joists are placed in a specially designed frame where concrete casings with mild steel reinforcement are cast in moulds around the tension flanges.

The beams are slowly released when the concrete has hardened and their elastic recovery causes the concrete to become compressed, with a corresponding reduction of stress in the steel joists and a greatly increased stiffness. Thus when the beam is subjected to working load as part of a structure the concrete casing is decompressed, with no possibility of cracking. Furthermore, the range of stress under load is reduced, giving the beam increased resistance against fatigue. After erection, rigidity is further increased by encasement of the remaining steel profile of the beam. This secondary casing normally forms part of the structure, i.e. the road slab in the case of a bridge, or floors in a building.

Preflexing each steel joist to the maximum design stress, that is to say bending the steel joist so that the maximum allowable stress is induced in the outer fibres over half the span of the beam, is equivalent to load testing each beam before it leaves the works. The measurement of deflections at all stages of preflexing affords a means of further checking by comparison with calculated values.

It is claimed that the advantages gained by the use of Preflex beams are of great importance from the point of view of both economy and planning. Using high-tensile steel to its maximum working stress, less steel is required to support a given loading, and at the same time, less concrete is required in comparison with other systems. Given the span, live load and an allowable deflection, this type of beam can provide the solution to any design problem requiring the least depth of construction, or alternatively, given a construction depth and loading, longer spans may be bridged than with any other constructional system. In buildings, minimum floor depths permit reductions in the total height or the incorporation of additional storeys where height is restricted. Freedom of planning may be obtained by the omission of internal columns, and Preflex beams can provide support for secondary members and formwork, allowing clear working space at all floor levels. For bridges and tunnels reductions in construction depth lead to savings in the cost of approach works.

Fig. 1. General view of the new quay at Ostend.

Erection problems can also be simplified, as special lifting points are not necessary and support for the deck is provided without the need for propping.

These beams, it is claimed, can be incorporated into any form of construction, whether structural steelwork, reinforced or prestressed concrete, since the final beam is composite and connections will be of the normal beam end type for steelwork and monolithic in the case of concrete. Holes can be provided in the webs of the beams to allow such services as heating, ventilating or air conditioning ducts to pass within the construction depth of the floor. The elimination of tension cracks in the concrete casing means that complete protection is given to the steel joist against attack by fire and corrosion.

Preflex beams were invented in Belgium, and since 1951 have been used there and in many other Continental and overseas countries in the construction of numerous commercial and administrative buildings, factories, tunnels and bridges. Of particular interest to readers of this Journal is the use of this type of beam in the reconstruction of a berthing quay at the Port

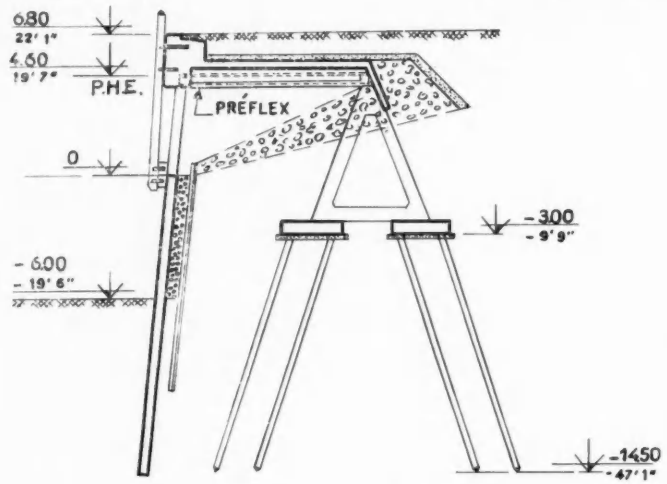


Fig. 2 (above). Cross section of Scheme adopted.

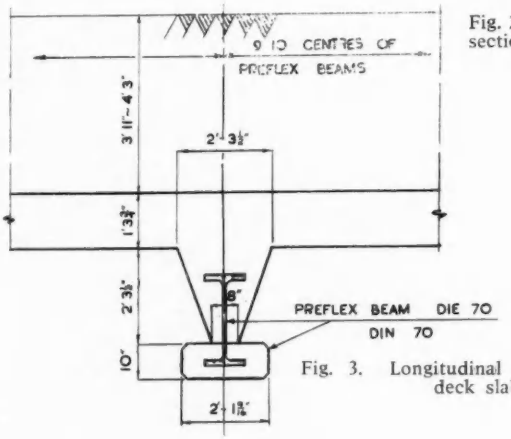


Fig. 3. Longitudinal section through deck slab.

of Ostend and details of the work, which was completed in less than 2 years during 1953-54 are given below.

The new berthing quay replaces a similar work which was destroyed by the German army during its retreat in 1944. Fig. 1 gives an overall picture of the new quay. It has a length of 1,320-ft. and a width of 36-ft. and is comprised mainly of a platform, supported at the front on a curtain wall of reinforced concrete sheet piling, and at the rear on prefabricated reinforced concrete trestles, spaced at 9-ft. 9-in. c/cs which, in turn are carried on four rows of inclined precast reinforced concrete piles. An impervious screen in steel sheet piling is driven on a line 3-ft. 3-in. behind the curtain wall (see Fig. 2).

The platform consists of a reinforced concrete slab, 15¾-in. thick supported on Preflex beams, encased in concrete, at 9-ft. 9-in. c/cs and of span 32-ft. 6-in. (Fig. 3). These beams are supported at one end on the longitudinal edge capping beam to the sheet piling and at the other end they are rigidly connected to the precast trestles (Fig. 4).

The beams are made of A.52 steel of profile DIE 70 and DIN 70 of which the lower flange is encased in precompressed concrete. The depth of the beams from the level of the underside of the prestressed concrete flange is 30¾-in.; the overall height measured to the level of the top surface of the slab is 53¼-in.

Perfect bond between the different elements is assured in the following way: the prefabricated trestles have projecting reinforcing bars at the upper and lower extremities (Figs. 5 and 6).

The bars projecting at the top are bent down on to the beams to obtain continuity between the beams and the trestles. The bars which project at the lower ends of the trestles are anchored

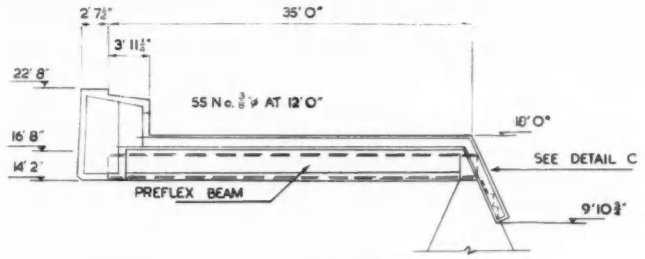


Fig. 4. Transverse section through deck slab.

in the concrete slab which is poured as a capping to the raking piles, after the correct location of the trestles (Fig. 2). In a similar way the Preflex beams are anchored firmly in the longitudinal continuous capping beam which ties the heads of the reinforced concrete sheet piles together, these sheet piles having reinforcement at their heads completely interlocked into the capping beam (Fig. 4). Longitudinal rigidity of the whole structure is further ensured by the introduction of a horizontal in-situ concrete beam tying the heads of the trestles (Fig. 7).

The entire structure; trestle, Preflex beam, sheet piling, has been considered in the calculations as forming a portal frame for all the superimposed loads. The method adopted for construction was chosen in such a way that the dead load of the concrete was imposed on the beams as simply supported.

The stipulations imposed by the clients, i.e. the Ministry of Works and Reconstruction were the following:

(a) an earth fill, 4-ft. 3-in. thick, i.e. imposing 455 lbs. per sq. ft.
(b) a uniformly distributed load of 820 lbs. per sq. ft.
(c) four concentrated moving loads each of 31 tons situated at the four corners of a rectangle of 15-ft. 3-in. x 19-ft. 8-in. for a crane which runs the length of the quay.
(d) a track for a railway.

The loads "c" and "d" need not be considered at the same time as "b" and the calculations have shown that a combination of "a" plus "b" gave the most unfavourable loading (Fig. 8). The maximum working load permitted in the steel of the Preflex beams was 16 t.s.i. (Since the time of construction of this quay, 1953/4, the working stresses officially permitted have been increased to 18 t.s.i.)

The construction of the quay has been carried out in six sections each 198-228-ft. in length. The mode of operation followed was identical in each section.

After removal of the rubble by the aid of a floating shear-legs a cofferdam in steel sheet piling was driven. This cofferdam used the steel piling in the front line (Fig. 2) the sheeting being extended up to the level +22-ft. 1-in., a second curtain driven at the back of the proposed quay, linked at each end by a lateral wall, either 198-ft. or 228-ft. apart as the case may be, so as to completely seal the area. At the same time as the steel sheet piling was driven along the front of the cofferdam, the reinforced concrete sheet piles were also driven.

As soon as the cofferdam was sealed the soil was removed down to approximately a level −10-ft. so as to expose the heads of the piles in the four rows at the back (these piles were existing ones from the original structure). While this digging was in progress the water pressure on the back of the cofferdam was diminished by a battery of filtering pits, whilst two rows of shorings linked the sheeting front and rear.

The heads of the exposed piles were cut off so as to permit the exposed reinforcement to be bent down into position when the seatings for the trestles were formed and the reinforcement of the foundation slabs put in place. During this time, on the opposite bank, the fabrication of the trestles was proceeding and at the

required moment they were brought over by a pontoon and placed into position.

When the trestle supports were ready, the trestles themselves could be positioned and temporarily braced against wind action Fig. (6). It only remained to concrete the foundation slabs so as to complete all the work below water level. Then the back fill of the cofferdam was carried out, the water allowed to enter, the rear row of sheeting withdrawn and the front row cut down to the required final level, working at low tides.

The work was organised so that when one section was water filled, the following section was ready for pumping dry.

Thanks to the use of Preflex beams the construction of the superstructure which was to follow was very easy. On the side where the trestles were located everything was ready to receive the beams. At the front the heads of the sheet piles had been cut off and where necessary the reinforcing bars were spread out to permit the formation of the support for the beams (9-ft. 9-in. c/cs). Each beam was 33-ft. long and weighed about 6½ tons (Fig. 9). The beams were lowered on to temporary supports

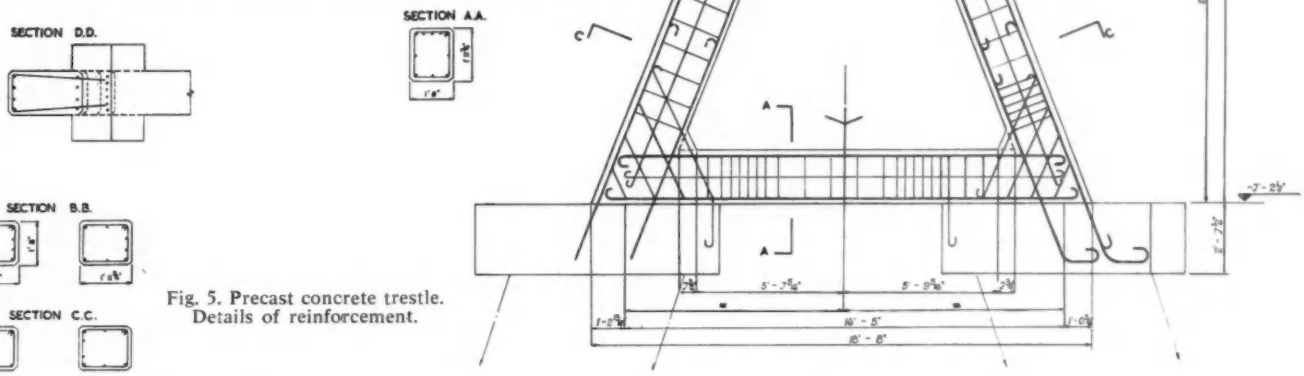


Fig. 5. Precast concrete trestle. Details of reinforcement.

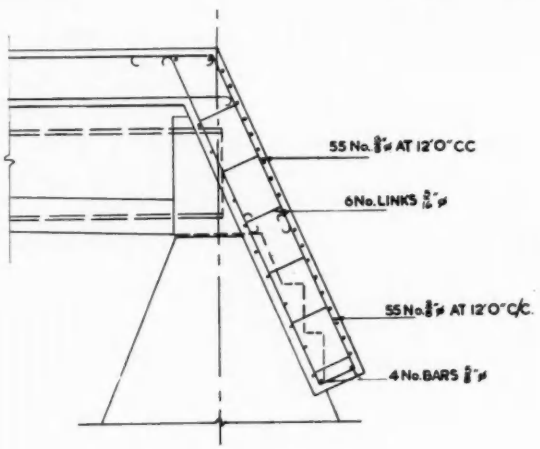
made up of little blocks of concrete sealed on the heads of the sheet piling and the trestles (Fig. 10). At this stage of the construction the beams are considered as freely supported (Fig. 11). Because of the use of prefabricated elements and ease in handling and placing the beams (Fig. 9) erection was rapid and simple and permitted a regular advance in the different stages of the construction.

Once the beams were placed in position they were encased in concrete up to the level of the underside of the deck slab. Then followed the shuttering and the placing of the steel reinforcement for the deck as well as its concreting and the banking-up of the earth on the water side. The projecting steel reinforcement in the trestles was carefully bent down into the deck for concreting in position so that the theoretical aspects of the design were scrupulously followed. Besides the necessary reinforcement in the deck the webs have been reinforced to resist shear stresses (in the upper part of the concrete above the steel beam). The shear connectors, welded on to the top flange of the beam (Fig. 11) and the inclined bars passing through the web oppose the horizontal forces and prevent any tendency to sliding between concrete and steel beam. These bars in A.37 steel and of ⅞-in. diameter are placed in the end quarter spans of the beam where the shear forces are greatest. In the central portion of the beam a much lighter reinforcement comprising 9/16-in. diameter stirrups, is used, the stirrups being welded to the web (Fig. 12).

No temporary supports were required for any of the work described above. Once the beams were placed in position they alone served to support the shuttering for the deck for the placing of the in-situ concrete (Fig. 13). It is certain that because of this the construction of the superstructure has been remarkably simplified.

Fig. 6. Prefabricated concrete trestles.

In the case of this particular quay account had to be taken of the presence of the old structure. This demolished structure had consisted of a deck slab of reinforced concrete, 4-ft. 10½-in. thick, resting at the front on a continuous row of reinforced concrete sheet piling forming a wall on the water side and at the rear on six rows of inclined piles. The sheet piling had a length of about 60-ft. whilst the piles were 60-70-ft. A curtain wall of steel sheet piling, driven at 3-ft. 3-in. behind the reinforced concrete sheet pile wall, served to retain the earth materials located under the deck platform (Fig. 14).



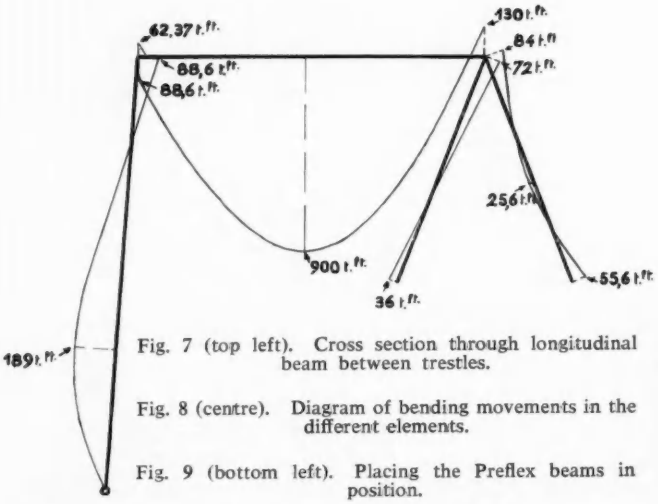


Fig. 7 (top left). Cross section through longitudinal beam between trestles.

Fig. 8 (centre). Diagram of bending movements in the different elements.

Fig. 9 (bottom left). Placing the Preflex beams in position.

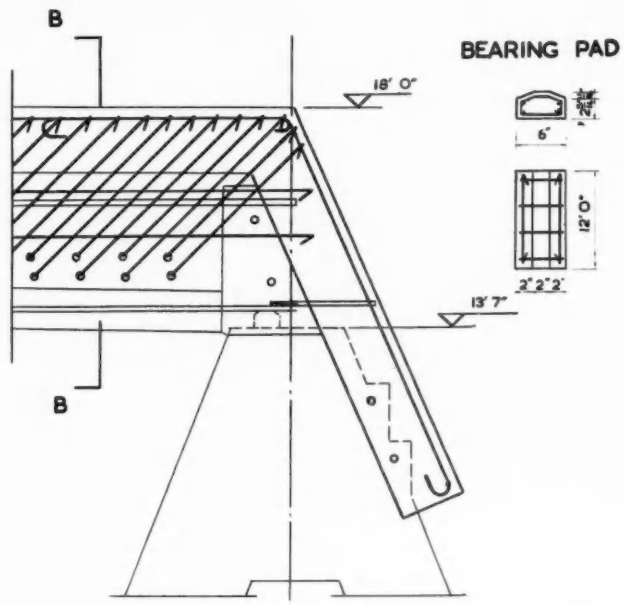
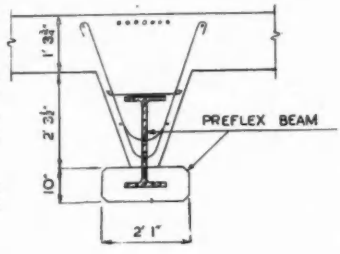


Fig. 10 (top right). Temporary bearing for Preflex beam.

Fig. 11 (centre). Preflex beam in position; note the projecting reinforcement from the precast trestles, and the shuttering for the longitudinal wall linking the trestles.

Fig. 12 (right). Section through a Preflex beam showing reinforcement in the concrete encasement.



After the dynamiting of the structure the destruction was practically complete. Except for the fact that it could be supposed that the four rows of piles at the rear, below the level 9-ft. 9-in., might be re-usable, the deck slab, curtain wall of sheet piling and the piles in the front two rows formed a complete mass of debris.

A first scheme and which was considered for the reconstruction, was to rebuild the quay to its former outline, re-using the portions of the rear piles which were supposed to be undamaged (Fig. 15). The work was thus to comprise:

(1) The removal of all the debris resulting from the demolitions and the withdrawal of the piles and sheet piles which were no longer usable.

(2) The driving of a new curtain wall of sheet piling and a new row of piles.

(3) The lengthening of the four rear rows of piles from level 9-ft. 9-in. up to +14-ft. 3-in.

(4) The construction of the deck slab.

The solution presented by the successful tenders (Fig. 2) was

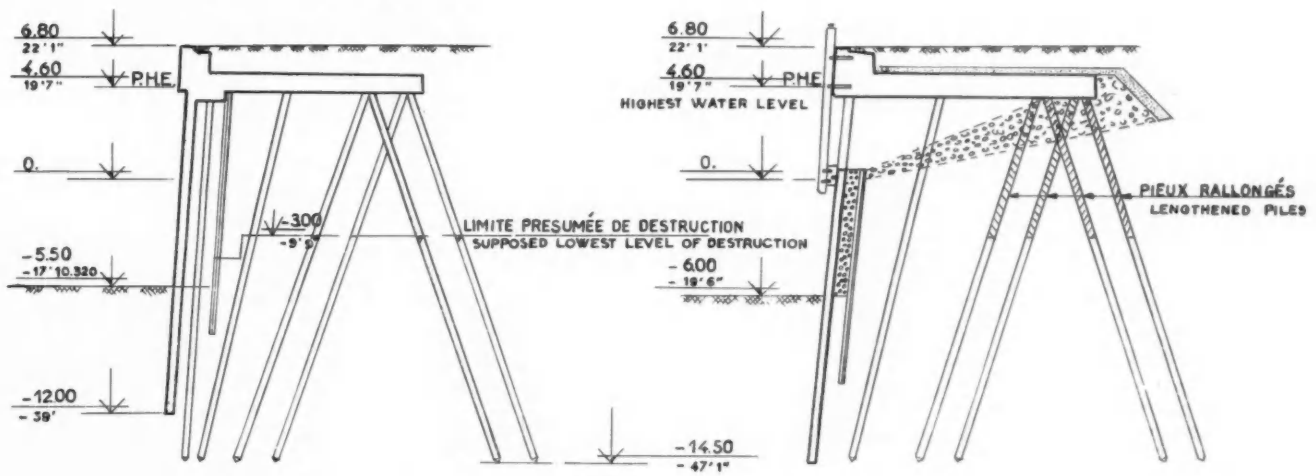
Fig. 13. Shuttering for the deck slab. (Reinforcement for linking the Preflex beam with slab.)

So as to care for the saline atmosphere, the precompressed concrete was made using blast-furnace cement which was also used for all the other concrete elements of the structure.

The further concreting on site of the beams and the construction of the deck slab was facilitated by virtue of the fact that the shuttering was supported directly on the precompressed concrete surrounding the bottom flanges of the Preflex beams. No precautions against water due to high tides (which reached a level of about +19-ft.) were necessary.

The use of prefabricated concrete trestles overcame the necessity to lengthen the rows of piles which existed at the back from the old scheme. Had it been necessary to lengthen these piles a certain risk would have had to be faced, since although the theoretical inclination of the raking piles, which were to be reused, was known, the actual conditions and positions of them was an unknown quantity. Without exposing the piles to a lower level than that of −9-ft. 9-in., which was not at all practicable, there might have been difficulty in being assured of perfect alignment of thrust through the lengthened piles.

Thanks to the prefabrication of the trestles, it was moreover



well received and accepted by the authorities because it showed a saving of 16% on the scheme envisaged above (Fig. 15). The reduction in cost of the work was due to the following factors:

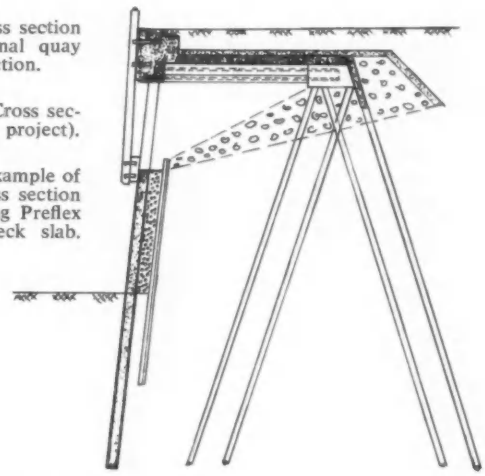
The introduction of transverse beams permitted a reduction in the thickness of the deck slab. In the first scheme it measured 4-ft. 10½-in. thick. In the accepted scheme it was only 15¾-in., resulting in a considerable reduction in dead load, permitting the omission of one row of piles (Figs. 2 and 15).

Having regard to the high tidal water level it was necessary to envisage the use of prefabricated elements to avoid the necessity for a cofferdam for the construction of the deck slab. Beams in prestressed concrete would have occupied more space, been heavier to handle and would have created difficulties from the point of view of tying the structure together; whilst ordinary steel beams, encased or not, were out of the question because of the fact that they would become immersed with sea water at each high tide. This would very soon have resulted in corrosion. A simple casing of steel beams with concrete does not afford protection because this concrete is always liable to crack, whilst on the contrary, in the case of beams actually used, i.e. the Preflex beams, the concrete surrounding the bottom flange of the steel beam is precompressed and is always in a state of compression, assuring a perfect protection for the steel. From all points of view, therefore, the Preflex beams were the most advantageous to use.

Fig. 14 (left). Cross section through the original quay before destruction.

Fig. 15 (above). Cross section of quay (first project).

Fig. 16 (right). Example of a new quay; cross section through quay using Preflex beams for the deck slab.



possible to considerably reduce the time during which it was necessary to keep the ground inside the cofferdam perfectly dry.

Finally it is worth noting that if the structure described above had to be built on an entirely new site it would still be the most economical, because the slab supporting the trestles and the trestles themselves could be omitted and the Preflex beams be

Berthing Quay at Ostend—continued

supported direct by the raking piles. The heavy capping beam would have assured perfect liaison with the deck slab (Fig. 16).

The execution of the work described in this article was carried out in 600 working days, of which a large portion was devoted to the work of demolition and clearance of debris.

The construction of the quay involved the following:

Demolition of reinforced concrete	264,000 cu. feet
Withdrawal of sheet piling	
in reinforced concrete of 50-ft. 6-in. length	No. 786
in steel of 40-ft. 6-in. length	No. 416
piles in reinforced concrete of 61-ft. 9-in. length	No. 399
Amount of debris removed and dredging	3,110,000 cu. feet
Amount of filling	211,500 cu. feet
Amount of massive drainage	42,400 cu. feet
Amount of reinforced concrete	46,600 cu. feet
Amount of driving of sheet piling	
in concrete	No. 840
in steel	No. 734
Placing of prefabricated trestles	No. 133
Placing of Preflex beams	No. 133
Formation of road in concrete	1,615 sq. feet
The total quantity of reinforcement placed	1,630 tons

The work was carried out under the direction of Monsieur J. Verschave, Engineer in Chief, directing the Coastal Department of the Ministry of Works and Reconstruction, by the firm Sotrahy of Brussels under Monsieur P. Th. Cerfontaine, President, and Monsieur Leon Luyckx, Technical Director, with the collaboration of Monsieur A. Lipski, Consulting Engineer, who evolved the design.

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Integration of Transport Systems

Increasing Importance of Container Traffic

By ANTHONY F. ARPAIA

In the April issue of this Journal, we printed extracts from a Paper on "Integrating Truck Service into Container Operation," which was read at the I.C.H.C.A. symposium on "Modern Systems of Cargo Handling" held in New York last September. Another contribution to the solution of the container problem was made by Anthony P. Arpaia in an interesting paper on "Integration of Transport Systems."

In introducing his subject, Mr. Arpaia drew attention to the volume of container traffic, which, he said, "is growing at a rapidly accelerating pace. True," he continued, "its growth was slow initially, but this has been characteristic of the transportation industry. It has been proverbially cautious, timid and suspicious.

"Nevertheless, week after week the figures show high percentage growth. For example, the cumulative 'piggy-back' loadings for the first 33 weeks of 1960 totalled 348,514 units, an increase of 35·5 per cent over the same period in 1959 and 115·1 per cent greater than 1958. But, the trouble with figures, averages, and statistics is that they tend to make us complacent.

"The ultimate function of containerisation is a means of producing easy interchange and the true integration of service. If it is treated as an end initially, its value is limited. Let us not be mislead by the dramatic growth which these figures seem to indicate. The real question is how much containerised traffic was in fact interchanged with other carriers—even of the same mode? Do the present developments and the high percentage rate of growth prove that integrated services are also growing at the same rate?

"Virtually every movement in integrated service to and from foreign points originates and terminates at an inland point. A current maritime problem points this up. One of the few ship lines which have made courageous and substantial investments in containers and container ships, faces the frustrating task of selling the railroads, the motor carriers and the inland forwarders the idea of co-ordinating and integrating their several services in through container hauls from and to interior points.

"Therefore, in discussing through container systems, let us take the railroads, alone, as Exhibit A, since, if there ever was anything that can be classified as a **system** in transportation in this country, it is, or should be, the rail network. Yet, out of 112 Class 1 railroads in the U.S., only 55 as of today handle piggyback traffic and the number of these which co-ordinate with each other is limited. Of the 55, less than half co-ordinate with independent truckers under Plan 1. The number of ocean carriers and water carriers who have taken the first step and containerise at all is even less impressive.

"It should be clear, that in spite of a lot of talk and activity about containerisation—and considerable philosophising about integration of services — the results to date have been meagre. Yet, every poll of shippers I have ever seen has strongly endorsed co-ordinated service and several committees and task forces have been working hard to resolve the physical problems of the methodology of interchanges."

Public Transport and Containers

Mr. Arpaia then went on to ask whether concern about the relatively slow growth of container use in co-ordinated service is a valid one. He believed it was.

"Public for-hire transportation has stopped growing. Why? The need for transportation has not declined. In fact, it has grown with our expanding economy, population and world commerce. One would think that with this background, carriers would have seized upon this opportunity to reverse the downward trend of their percentage share of the total traffic with enthusiasm, diligence and energy. Yet, the belated push for containerisation is more to be ascribed to sheer economic pressure rather than affirmative co-operative effort to respond to customer desires and needs. Rising costs of labour and materials, and an inability to raise rates in a competitive transportation market, have forced what little action there is.

"The failure of public transportation to take advantage of what is probably the clearest, most demonstrable expedient for curing its ills—containerisation and greater intercarrier co-ordination and integration—is hard to explain. It certainly has not been done on the basis of logic or reason. We can only speculate.

If public transport is the sick man of our economy, its source of illness is not physical, it is a matter of attitude.

"That there is a deplorable division and lack of cohesive judgment and action in the tranportation industry goes without saying. Why does it exist and why does it persist?

"Its origin may have been engendered by Federal law, policy and example, and its continuation fostered by the sense of unequal treatment which the various segments of regulated transportation feel exists between themselves and, also, between all of them, on the one hand, and unregulated transportation, on the other.

"The law treats each mode of transportation as a separate breed. Each has strong motivations to regard itself as different because each is subject to different provisions of law. Some, of course, are supervised and regulated by separate agencies with different policies and objectives. This lack of unified treatment in the highly competitive transportation field tends to kill objectivity and common purpose."

Coming to the crux of his argument, the speaker stated that, in contrast with the carriers, " the shipper thinks in terms of **transportation,** not in terms of railroads, trucks, buses, ships, barges, and aeroplanes—its components. Our present economy, an increasingly more decentralised industry, and the growth of world commerce each are helping to create a larger and larger sphere of traffic which cannot be handled by a single mode of transport. Under such circumstances, a transportation service adapted to a shipper's full requirements from beginning to end, without the turmoil and labour of making subordinate arrangements for each leg of the haul, is becoming more and more pressing.

"Since a divided industry has not shown much interest in meeting the needs of shippers, more and more of them have sought —and found—other alternatives. Carriers are too slowly beginning to realise that the 'take or leave it' attitude does not work; that forcing shippers to take the initiative has placed them in a secondary position. Yet, in the face of these factors, which, in effect, compel integrated services, the majority of carriers are temporising.

"In spite of this resistance, it is not hard to predict that the force of economics eventually will prevail. Whether public transportation as private enterprise can survive during the interim, if it is too long, is another question. Carriers, labour, and government must become realistic and sensitive to what is needed now by producing flexible, integrated services. If not, we may all have lost a last clear chance for the survival of a great and vital industry under private ownership."

Turning to the technical questions involved, Mr. Arpaia argued that, once there is a unified demand for action—once, that is, the principle of integration had been accepted with determination —the attendant mechanical problems could be solved. The present disjointed, disorganised, pot pourri of transportation services was completely unsatisfactory from the shippers' point of view. "Again and again, the immediate and important benefits of containerisation—improved transit time through avoidance of multiple handlings, the virtual elimination of loss through pilferage and damage, lower insurance rates, savings in labour costs, reductions in the costs of packaging, faster turn-rounds, improved service to the customer—have gotten the spotlight. But that is not the end of the story; it is only the beginning.

"I foresee other deeper and more fundamental changes likely to emerge from containerised service which would make patronage of for-hire transportation more appealing and attractive to shippers."

"One of the points of resistance to the use of public carriers is the hopeless complexity of tariffs. And it is here that containerisation and integration may become dynamic catalysts.

Rates and Charges

"The employment of a public carrier has become a major undertaking. Charles Eliot's five-foot shelf, which was supposed to hold all the essential knowledge of man, could not begin to hold the forbidding volumes of tariffs, routing guides, rules, regulations, etc., with which a shipper has to contend. The railroads alone issue some 12,000 tariffs, many of them, with effective supplements, as large as five or six inches thick.

"Tariff reading and interpretation make logarithms and calculus child's play by comparison. Recognising this, transportation companies and the regulatory agencies have tried to simplify them, without success. Tariffs are baffling, confusing, and complicated. A mistake can cause serious consequences since the law places upon the shipper a definite responsibility for tariff knowledge. The monster they have to deal with today frightens them.

"A radical and fundamental change of technique in computing charges must therefore be found—something which meets the needs of the second half of the Twentieth Century, the keynote of which is speed and efficiency. The crude methods of the Nineteenth Century are out of harmony with electronic computers and automatic business machines.

"Now, technology is almost daily creating new varieties of articles which were either non-existent years ago or are so altered in their pricing, processing, or composition that a comparison, from a transportation standpoint, no longer exists.

"Thus, it is virtually impossible to define the myriads of articles now offered for shipment and do so with sufficient particularity for classification purposes. The most awkward rule of the classification is that which says that parts or pieces constituting a complete article will be charged at the rating set for the complete article. At one time all the components, except the nuts and bolts, were clearly identifiable as parts suitable only for a particular appliance or machine. Now a vacuum tube or an electrical relay may be used interchangeably in a low-rated radio or phonograph or television set or a high-rated piece of scientific equipment. The same article may pay a dozen different rates, depending upon whether it is shipped separately or as a component of as many different finished products. This creates a built-in inequity in transport rates."

Cubic Measurement Basis for Charges

After emphasising the importance of these tariff and rate matters to the future of the common carrier, Mr. Arpaia went on to discuss exactly what a carrier has to sell. "Two things," he stated. "Space in a vehicle and the distance the vehicle is carried. Nothing more. Once the cubic capacity of a vehicle or ship has been used up (subject to maximum weight limitations of the vehicle or of law) the carrier can add no more for that trip, regardless of weight.

"This prompts my discussion of one approach to a revamped rate-making possibility worthy, at least, of serious study and exploration.

"What fairer way is there to classify packaged freight than through cubic measurements and to make rates on a cube-mile concept with specific accessorial charges where necessary and appropriate? The sheer simplicity of this type of rate-making might, in one stroke, clear up one of the great handicaps and expense items of public transportation. For-hire transportation could become less expensive, understandable, simple to use and palatable. Gone would be the stacks of volumes, the mystery, the confusion and complexity of transport.

"The curse of public transportation is unused vehicle capacity. A great part of the effort of carriers through incentive rates and other means is to reduce this factor. Empty space probably is

the greatest thief of carrier profitability. Nobody has made money transporting air. If a cube-mile concept were substituted, it is reasonable to expect that shippers would—out of self interest—produce more economical and efficient shipment packaging.

"The demolition of the façade of the pre-competitive tariff edifice can be hastened through the progress of containerisation, co-ordination and integration, in my opinion. When the structure is torn down, and a new one built, one of the great deterrents to the use of public carriers will have been removed. The resulting economies and efficiency of integrated service will automatically reverse the position of regulated carriage vis-a-vis unregulated carriage. The common carrier industry and regulatory bodies through joint effort have the power to remove regulated transportation from its deep freeze and bring economic order out of the present chaos and instability which surround it."

Integration

"I know," he continued, "that transportation people are responsible citizens with a deep sense of obligation and respect for the welfare of our free enterprise system. They realise that if the direct as well as the indirect advantages of integration are effectively to serve a large cause, then they must reach into every distribution point in the interior of very country. Therefore, although it will be necessary to have specialised containers for specific uses to serve their full purpose, every container must have uniform or compatible equipment for handling and transfer from one type of vehicle to the other, whether ship, barge, rail, motor or air. This is the only way to make integrated service work.

"For this reason, in my opinion, standardisation of sizes is not as essential as interchangeability and compatibility. Containerisation is not an end, but a means—a way of moving miscellaneous commodities from one place to another, wherever located, better, quicker and cheaper. Integration or co-ordination—call it what you will—is a vital instrument, not only to preserve our transportation system as private enterprise, but to assist in the preservation and advancement of the same freedom for the peoples of the world.

"As you who represent the maritime interests so particularly know, world commerce is vital to the welfare of all nations, not just ourselves. We cannot remain parochial and static in our attitude in the face of the strong pressures on the economy of a shrinking free world. Goods must be exported as well as imported to keep economic balance. With our decentralised and highly diffused system of production, it is unnecessary to point out that most goods are not manufactured or processed at outbound port city piers, nor are they consumed or used at destination port cities."

The Future

In a forceful conclusion, Mr. Arpaia spoke directly to the representatives of the various segments of transport present. "It is for us to take charge," he said, "for us to accept the challenge with open minds, firm determination, and bold steps so as to reverse the process of erosion of public transportation and to restore it as a dominant force for progress, peace and prosperity. More courageous experimentation definitely is in order.

"We hear much urging for a transportation revolution. Many people are concerned about the apathy of the transportation industry. It is high time for the old methods to be supplanted—not supplemented in grudging fashion.

"I hate to end a talk on this note, but perhaps it is an effective way of dramatising the current timidity of transportation thinking—which has no place in a major industry. Just a month ago I read the following appraisal of an industry leader toward containers: 'I would urge you not to panic. Not to start a stampede toward a system which is yet unproven.' I will not comment further except to say that there are still some people who—because they cannot see it—do not believe there is oxygen in the air."

To port users, one of the most important aspects of this problem is the future of containers in the field of handling general cargo. Much container traffic, particularly in the United States, can be classified "special," because at certain points in the "throughout movement" of cargo from shipper to receiver, there are special requirements. Sometimes the road vehicle must be of a special design, frequently, special handling equipment is necessary—and, although we would not contradict Mr. Arpaia's statement that standardisation of sizes is not at present essential, we would emphasise that standardisation of certain aspects of construction is very important.

In the endeavour to extend the field of use of containers, the experience of industry during the experimental period with pallets should not be ignored. After a decade or more of serious development, palletisation still creates difficult problems for transporters and handlers alike and the problems connected with the integration of containers are in the main of similar type. As Mr. Arpaia states, these problems can only be solved if the interests concerned—and there are many—tackle the question jointly and with determination.

Port of Antwerp Dry Dock

Ship Repair Facilities in No. 4 Basin

The new ship repair facilities of Messrs. Beliard, Crighton and Co. are located at the end of No. 4 Basin at Antwerp and cover an area of more than 15 hectares. They were put into commission in May 1959 and comprise a dry dock capable of accommodating vessels of up to 42,000 tons, quay walls with a total length of 475 m., a jetty 195 m. in length, and ancillary buildings.

The dry dock has an effective length of 225 m. and a width of 33.50 m. in the dock chamber. The entrance width is 30.50 m. The sill level is −4.50 m.; the level of the dock floor immediately behind the sill is −5.40 m., rising to −4.70 m. at the far end, thus producing a fall from the head of the dock towards the entrance. In the transverse direction the floor has a 1 in 70 fall, on either side of the centre-line, to a drainage channel along each side of the dock. The floor is composed of an end section 18.50 m. in length, seven normal sections of 24 m., and a 42 m. long section at the entrance. The last-mentioned section is 5.50 m. thick, whereas the thickness of the other sections is 4.50 m. Joints sealed by double polyvinyl water bars, 36 cm. wide, separate the sections from one another. At each joint one of the water bars is continued up into the dock walls.

It is intended subsequently to construct a second, larger dry dock immediately beside the new dock described here, and the entrance section of this future dock was built at the same time as the present dock, to the north of the latter. Surmounting the intermediate pier which separates the two entrances is an ancillary building in which is accommodated the electrical equipment for operating the pumps, gates, sluice valves, etc. Under this building is the pumphouse and the chamber containing the compressors which supply the compressed air used for driving the pneumatic tools used in ship repair work. Above the compressor chamber are compartments containing low-tension and high-tension electrical gear respectively. A walkway at the level +3.80 m. goes right round the dock. Services are accommodated in a 2 m. wide tunnel integral with the upper part of each side wall of the dock.

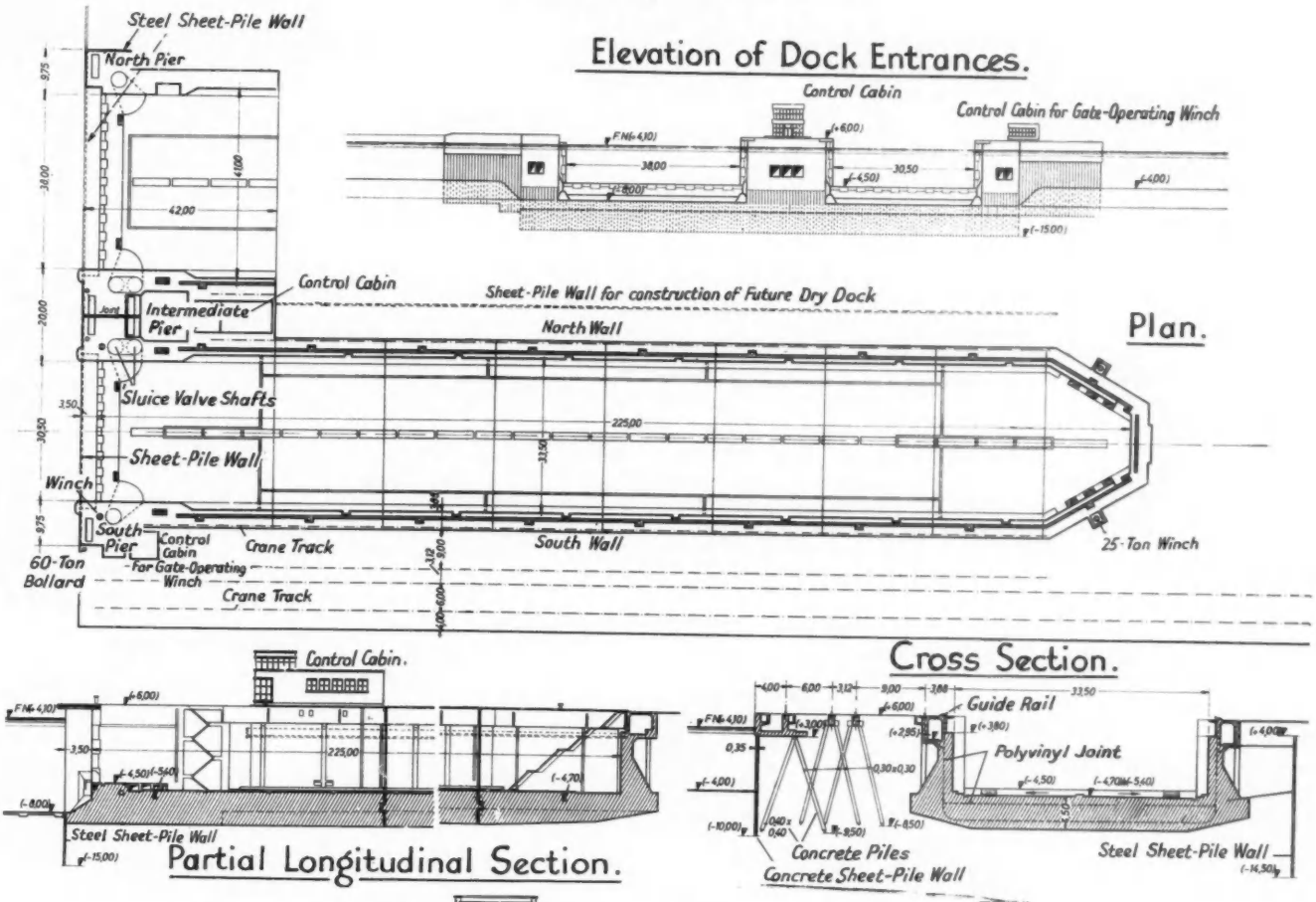
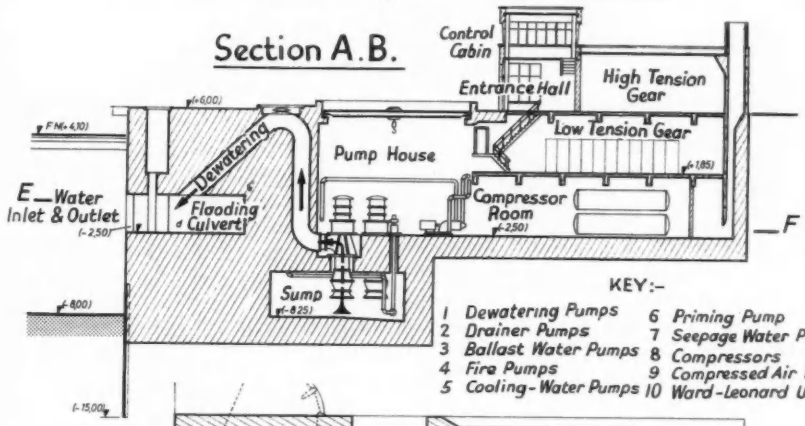


Fig. 1.



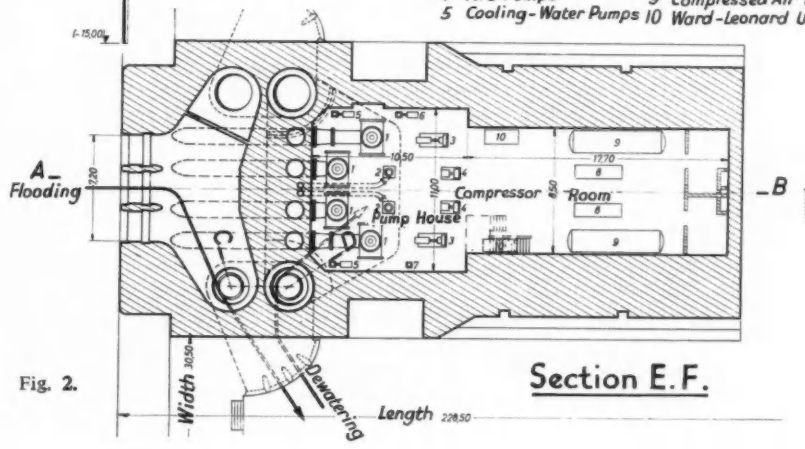


Fig. 2.

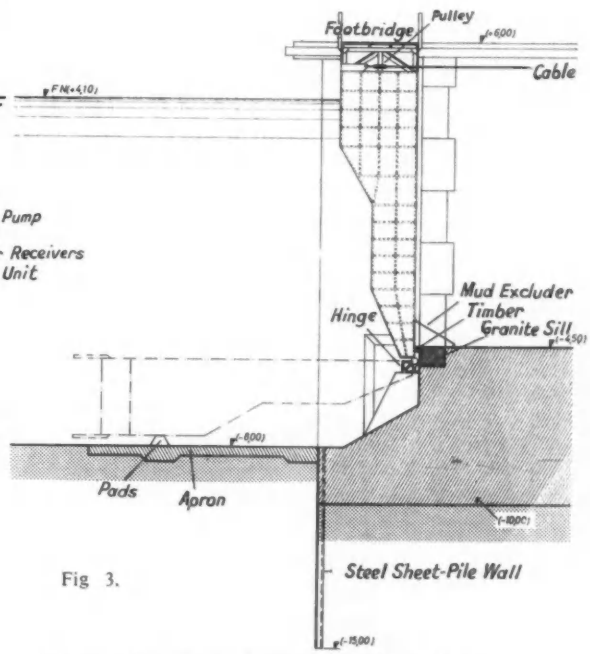


Fig 3.

Antwerp Dry Dock—continued

Vessels entering and leaving the dry dock are manœuvred by means of two 25-ton hauling winches and by two guiding carriages running on inclined rails. In addition, the intermediate pier between the two dock entrances is provided with three mooring bollards, each capable of resisting a 60-ton pull.

The dock is provided with a flap gate (or "Box" gate) consisting of a multi-cellular steel hinged leaf containing ballast chambers and buoyancy chambers. The gate is carried on two trunnions supported in cast steel half bearings. If it becomes necessary to remove and tow away the gate for repairs, it can be lifted out of its bearings by buoyancy obtained by discharging a larger quantity of water ballast. The operations of opening and closing the gate are effected with the aid of a cable anchored to the intermediate pier. This cable passes around pulleys installed on the top of the gate and is fixed to an operating winch mounted on the south pier of the dock entrance. In the open position the gate rests on two reinforced concrete pads constructed on the apron in front of the entrance. The meeting faces are formed by greenheart timbers bolted to the steel framework of the gate. These

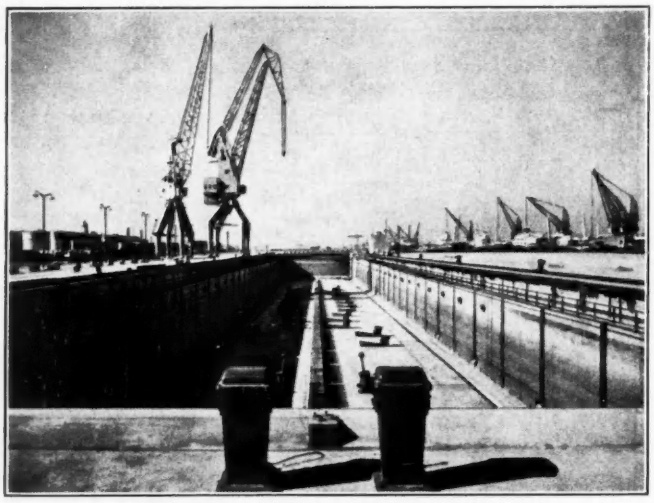


Fig. 4. View of the completed dry dock.

timbers are provided with a rubber seal, or gasket, to ensure complete watertightness. The greenheart timbers bear against the finely dressed granite sill and jambs.

Flooding the dock is effected through an inlet opening, 7.20 m. wide and 2.50 m. high, located in the intermediate pier, and through a second inlet opening 3.30 m. wide and 2.50 m. high, in the south pier of the entrance. After flowing through a sluice valve of 2.50 m. diameter installed in each flooding culvert, the water enters the dock chamber on each side through an opening, 1.25 m. in height, which is quadrant-shaped on plan and is provided with gratings to intercept floating objects.

When the dock is being dewatered, the water drains away through the quadrant-shaped opening on the north side of the entrance, flows through another 2.50 m. diameter sluice valve, and reaches a sump of 350 m^3 capacity. The sump floor is located at −8.50 m. The suction bellmouths of the two main dewatering pumps for the dock under consideration (and also the pumps for the future dock) project downwards into this sump. The water is forced by the pumps through 1.20 m. diameter discharge pipes, each of which forms a syphon, and is delivered into the inlet chamber of the flooding culvert, which is in open communication with the outside water. At the highest point of each syphon is a relief valve, providing protection against water-hammer effects.

When the dock has been dewatered, the ship comes to rest on a row of keel blocks spaced at 0.80 m. intervals. These blocks are each composed of five cast iron units, two of which form a pair of folding wedges for adjustment of levels, and are provided with oak capping pieces. In addition, there are twenty bilge blocks, which are manipulated by chains from the walkway. These bilge blocks, together with eighteen bollards mounted on the side walls, serve to locate and secure the vessel in position.

Two travelling cranes run on tracks along the south side of the dock. The larger of these cranes has a lifting capacity of 25 tons at a radius of 28 m.; it travels on a 9 m. gauge track. The other crane has a capacity of 7.5 tons at 25 m.; its track has a gauge of 6 m.

The four most unfavourable loading conditions for the overall structural design of the dry dock were as follows:

(1) Dock empty, surrounding soil dry, side walls carrying superimposed load.
(2) Dock empty, ground water table at +4.10 m., side walls carrying superimposed load.
(3) Dock empty, ground water table at +4.10 m., superimposed load on backfill, vessel resting on keel blocks.
(4) Dock flooded, soil dry.

Each section of the dock floor was designed as a slab resting on an elastic base and subject to loads exerted by the walls (self-weight and superimposed load of these walls, as well as the bending moments produced at their base by earth and water pressure). The earth pressure introduced into the calculations was taken as being equal to the "neutral" pressure, corresponding to about twice the active pressure, so as to take account of the fact that the side walls, being integral with the dock floor, cannot undergo any displacement (as distinct from an ordinary retaining wall, which will "give" slightly, thus reducing the earth pressure to its "active" value). For the above-mentioned loading condition (1) the transverse bending moment in the floor on the centre-line of the dock is 820,000 kgm. per lineal metre (corresponding to a state of tensile stress at the top of the section); the maximum compressive stress in the concrete (on the underside) is 40 kg/cm^2; the bearing pressure on the soil is 15,000 kg/m^2 at the centre of the floor, and 24,300 kg/m^2 at the edges.

The excavation for the dock was formed mainly by dredging. The mouth of the excavation was closed by a double-walled sheet-pile cofferdam. Well-point dewatering was used for keeping the excavation dry. The concrete for the construction of the dock chamber was made in a central batching plant equipped with two mixers of 1,650 litres capacity. The floor concrete was placed by lorries and by grabs suspended from cranes with an outreach of 27 m. Three tower cranes were used for the construction of the dock walls.

Improved Berthing in Aden

The Trustees of the Port of Aden will shortly go to tender on the first stage of a scheme to convert buoyed oil berths in the Inner Harbour to Dolphin Berths. This will give greater security to the many large ships now using the port, will speed up berthing and so improve turn round. In addition it will make the berths available on either flood or ebb tide whereas at present they are tidal.

The project is to instal two massive piled dolphin strong points in each of three berths of sufficient strength to withstand normal berthing impacts from the largest vessels likely to call at Aden. Warping and securing arrangements will be to breast buoys laid in line about 200-ft. inshore from the berths. It is anticipated that the work will take eighteen months to complete.

The dolphins will be of braced steel box pile construction with rubber cushioned fender piling. Each will have a berthing face of about 60-ft. and will be placed at 200-ft. distances centre to centre.

Why Not Abolish Tallying?

By POSEIDON

From September 20 until October 17, 1960, the Port of London was paralysed by the second strike of tally clerks in three years. During the 28 days the stoppage lasted, 196 ships bound for London were diverted to other ports and 125 left either incompletely loaded or discharged. The situation was described on October 12 by the chairman of the National Association of Port Employers as "truly catastrophic"; it is estimated to have cost the industry £2 million. Who can say what was the loss to shippers, lighterage and railway concerns; who can eradicate the exasperation from overseas receivers who waited in vain, as cargo piled up in the dock sheds and weeks went by with no news of urgently wanted machinery or equipment required for new factories?

At the time of the strike, 1,660 tally clerks were registered by the London Dock Labour Board. Their earnings, with overtime, were in the neighbourhood of £20 per week, higher than those of the docker or stevedore. Since May 1960 there had been daily shortages of 125-250 tally clerks in individual weeks. As gangs will not work without a clerk an equivalent number of gang-days had been lost to the port. Tally clerks have always regarded themselves as the élite of dock labour; by 1960 they had achieved a scarcity value which they saw imperilled by the sensible and businesslike move by the N.D.L.B. to add a further 50 names to their register of tally clerks. Hence the strike.

It differed however from the unbroken run of stoppages and disputes that have for long bedevilled London port labour, in that port users are, some months later, still asking how this malaise can be cured. It is reminiscent of the French who said in the 1930's, regarding the German menace, "we must put an end to it." This will not be done by deploring the lack of patriotism of the docker or by asking the government to give "urgent consideration to this serious menace to the future of our overseas trade." The remedy lies in the industry's own hands—it is to abolish import tallying.

Few occupations are more rewarding to the port operator than to question the value of an accepted practice. All progress starts with an irreverent "why?" from anyone who has been blessed with a fine disregard for the rules of the game. In our ports many of these rules were laid down in the Tudor days of maritime expansion. When the docks in London were built in the early 1800's several already had the force of "customs of the port"; an apparently unanswerable argument to the iconoclast and the innovator. If he persists he is reminded that a custom of the port is recognised as such when no written authority exists for the practice. The inference is that as no written authority exists no written authority can now demolish it. A comforting argument for the traditionist but a fetter that should long since have been struck off the industrial limbs.

Let us examine the arguments that will be produced in favour of tallying, for it is certain that many interested parties will leap to defend a system that has, for any good that it has done, been with the industry far too long.

Firstly, "if you do away with tallying you will be inundated with claims." Those who have penetrated the mystique of dock work will recognise immediately the automatic recoil of the port operator from the possible arising of a claim. It may be the result of shortage or damage; it may be attributable to no fault of his own, but a claim is a thing to be avoided at all costs. Weird and wonderful are the means by which a shortage is "kept off paper." The author considers that if this bogey was dragged screaming into the second half of the twentieth century and put under the X-ray of commonsense it would disintegrate. Modern methods of dealing with claims will be referred to later.

Secondly, how are you going to pay the piecework or bonus earnings of the men working the cargo? They depend on the daily tally taken by the clerk and so do lightermen and others.

Thirdly, what will H.M. Customs say? They make extensive use of the tally clerk's figures. In the case of certain high value dutiable cargo their own "watcher" even takes an independent tally.

Fourthly, it is said that during the process of tallying, the clerk records items of cargo that have been damaged during transit or discharge and that this is a valuable aid to the receiver in preparing his claim against the ship.

Fifthly, it is asserted that marine insurance companies will not consider a claim unless it is supported by the record taken by a tally clerk at overside delivery.

There are probably a number of other objections that will have local or specialised application.

Let us now return to the one fear, if import tallying was ever abolished, that the shipping company (or the port authority) would pay out millions of pounds in claims. It is a very real fear; the imagination of the average dock official boggles at the prospect. The flood gates once thrown open to the rogue, the smart boy and the merely dishonest could never again, he feels, be closed. Does he not spend his working life protecting his employer's interests against those who seek to despoil him? This is the only possible mental attitude to be expected from the science of "dockology" as it has been built up by generations of workers.

Does it not, however, reflect only the individual recoil from so drastic a change? Is it not necessary to get the problem into perspective—to compare the cost of the present system with the cost of an absence of system? Before the second world war tallying cost roughly 5d. a ton for general bag and bale import cargo. Today it is about 2s. For hardwood lumber it is reckoned to be 3s. a load (about a ton). The cost of tallying a 10,000 ton dry cargo ship is roughly £1,000; this leaves out of account the clerical cost of manipulating the mass of statistics that the tally clerks produce—a process dear to the heart of the office worker. Looked at another way the earnings of 1,660 tally clerks are in the neighbourhood of £1¾ million annually. Add overheads and supervision and there will be little change out of £2 million.

Does the traditionalist really expect that £2 million would be paid out in claims each year? If it depended on his own limited resources it might be so, but it would not. He can visualise only a mounting flood of claims arising with each separate link in the chain of transportation. Fortunately it is possible to draw on the experience of officers who have made a life-time study of claims. They will tell you that:

(a) The average firm is honest in its public dealings.
(b) Claims tend to fall into easily recognised channels.
(c) The "smart boy" claim can soon be recognised, isolated and repudiated.

(a) No one will dispute that there are now fewer small importers than there were fifty years ago. Business amalgamations have reduced the number of receivers with whom shipping companies deal. The reputation of these is not to be evaluated in terms of an odd bale of wool or a few bags of asbestos. It would not take long for a "gentleman's" agreement to replace the initial money-wasting haggling. If one is asked where are the "gentlemen" in the docks, one can only answer that there are a surprising number who, in the author's opinion, would be ready to play in with any commonsense arrangement that would have avoided the last two calamitous stoppages due directly to the practice of tallying.

(b) Experienced officers will admit that there is a limited variety in the rendering of claims and that the few available are easily recognisable. The principal shipping companies operating

in United Kingdom ports do so under accepted Conference conditions. Their traffic is similar and their shippers and receivers are often identical. Would it not be both practical and economic for each Conference to set up its own "claims department," staffed by a few experts who would pool their knowledge for the protection of the Conference members? Given some freedom in the handling and settlement of claims for shortage and damage it is surely reasonable to expect that within a year or two the new arrangement would work soundly and fairly.

(c) To the author was once made a complaint that a system of mechanised handling of a certain commodity, which he had introduced, had deprived the importer of his opportunity to claim for damage. No longer could he inspect his goods with a view to formulating a claim that might have little more than a nuisance value but which would satisfy his need to claim from someone.

A Conference claims department would have the power to give short shrift to irresponsible claims. The experience of general insurance companies supports this view.

Summarising the claims aspect let it be conceded that legitimate claims would from time to time occur and would be paid. What cannot be conceded is that given expert administration the cost of the scheme, including paid out claims, would in London approach £2 million annually. Even were it to do so the industry would have removed one of the most deadly causes of strikes and stoppages—the tally system.

Having discussed the major objection to abolishing tallying let us look briefly at the minor troubles that the traditionalist would confidently predict. The use of the tally for paying labour is certainly convenient. Seeing that the Bill of Lading, the Manifest and the Ship's Plan give all the data required to regulate the process of discharge the exact (sic) daily tally is by no means necessary. Import gangs work on the Continuity Rule—that is, one gang works throughout in one hold. What they are not paid today they will get tomorrow. In any case, as the author has frequently experienced, a "winch end" tally is a thoroughly reliable substitute for a tally clerk.

The objections that might be raised by H.M. Customs would be given due weight by the Chamber of Shipping. What the working dock officer, overawed by the unknown powers of the local Surveyor of Customs, does not realise is that a change of the kind contemplated would be discussed, not at dock level, but with the Treasury.

The recording of damage by the tally clerk has a value that is often exaggerated. If there is damage within the hold, normally the shipping company will protect itself by using the services of a qualified surveying officer. Undetected damage, spotted by an astute tally clerk is generally superficial and claused receipts are more a protection than the basis for a subsequent claim by the receiver.

The employment of tally clerks because it is alleged that insurance companies require their cards as evidence of shortage is, again, one of those accepted statements which should be questioned. Certain insurance companies have already realised that the receiver's tally is reliable and that grounds exist for negotiation with the companies, with a view to dispensing with the ship's tally.

Hitherto we have dealt only with the major problem—tallying general import cargo. We have urged that reliance should be placed on the Bill of Lading which, from experience, has been rightly regarded as "the Bible" by all concerned. Surely the reverse process might operate for exports. At present—and it is admitted that practices vary with ports—the fundamental document is the Shipping Note. Against this the contents of the rail wagon, or the lorry, are checked into the export shed. Provided that no discrepancy is found, when, a few days later, the same goods are trundled out to the ship, the Bill of Lading is prepared from this same document which has meanwhile been transcribed on to the Mate's Receipt. Where is the need for a separate tally?

The author is only too aware that it took more than one blast on the trumpet to bring down the walls of Jericho. At the same time there are other and more insidious attacks on the tally clerks' bastion; one may assume that they are not unaware of the sapping and mining that is going on. Prior to 1945 the tallying of bags of sugar formed a staple industry within the tally clerks' empire. Today sugar in bulk, wine in glass tanks, cement in bulk and orange juice in specially built containers are among the many commodities no longer calling for a tally to be taken. How long will it be before the bulk of the general dry export cargo, now tallied in detail, will be containerised at a depot some miles from the docks, each container having tacked inside a "container manifest"?

The huge number of motor cars now exported are separately documented. What is the point of taking a tally of these? Unit loads and palletised carton traffic make futile the work of the tally clerk. Vast changes have taken place since 1945 in the working of cargo. Before these could be launched vast mental changes had also to be contemplated. Those responsible for the present mechanised working have rightly discarded the crippling adage "it has always been done this way." In its place they adopted "it **can** be done, because it has never been done this way before." A few tally clerks will continue to dominate the ports of this country until port users have the courage to devise means of dispensing with their services.

Two minor points in conclusion. American experts reckon that more than half of the retail price of an article is taken up in distributing costs. Of these 30% is accounted for by expenses incurred in transportation. One of the non-productive elements in this cost is that of tallying. If the standard of living is, as it has often been said, largely influenced by what goes on in the ports of a maritime country surely the government should welcome and support a measure that would bring down the cost of living.

The last argument of the peace-at-any-price school is that to do away with tallying would cause a strike. Of course it would. As it is certain that there will be a strike in the docks within the next year or two, why should not the employers choose an issue on which they would be bound to win? They would go far towards achieving "peace in our time."

Standardisation of Container Sizes in the U.S.A.

The U.S. Martime Administration has ordered that ships built to carry containers for which construction-differential subsidy or Government-insured mortgages are sought must be designed to accommodate standard sizes of containers newly-approved by the American Standards Association. The association's containers having a cross-section of 8-ft. by 8-ft. and lengths ranging from 10-ft. to 40-ft. are designed to fulfil a large range of shipper requirements. Speaking on this development, Mr. Thomas E. Stakem, chairman of the U.S. Federal Maritime Board said "The approval by the American Standards' Association of standard sizes for containers is of great importance to the merchant marine. The use of containers by ocean carriers as a means of reducing handling costs and providing improved shipper service is steadily growing. We expect that the publication of the standard will greatly enhance this growth by removing uncertainty as to future size trends and opening the way to complete interchangeability between rail, road and sea transport media. While the adoption of U.S. standards is a notable achievement, we must not stop here, but must press with all possible speed for international standards which are so necessary for foreign commerce."

Currents Produced by an Air Curtain in Deep Water

Report on Recent Experiments at Southampton

By P. S. BULSON, Ph.D., B.Sc., A.M.I.Mech.E., A.M.I.Struct.E.

SUMMARY

Large scale tests were undertaken in August 1960 in the Trafalgar Graving Dock, Southampton, to investigate the speed, power and thickness of horizontal currents produced by an air curtain in water up to 34-ft. deep. The maximum quantity of free air delivered to the manifolds by an air-bleed jet engine was 1·65 cusecs per foot. Measurements included horizontal and vertical currents, lateral and longitudinal distribution of surface current, amplitude and width of turbulence at the surface.

It was concluded that orifice size and spacing, and manifold arrangements are not influential factors, and that current thickness apparently varies logarithmically with a function of manifold depth. This is also suggested in a theoretical comparison of current and air power. The discovery of these facts has enabled a number of controversies to be set aside, and the way cleared for large scale tests under controlled conditions with waves.

1. INTRODUCTION

It has been known for at least half a century that a bubble curtain produced from regular orifices in a submerged air pipe can prevent the passage of waves, but only in recent years has the importance of the horizontal surface currents propagated by such a curtain and the nature of their damping actions been investigated mathematically by Sir Geoffrey Taylor[1], and experimentally, on a model scale, by Professor C. M. White[2] and Mr. J. T. Evans[3]. Model tests have been made in a number of countries, but none materially extend the knowledge recorded in the above authoritative papers.

Evans[3], in addition, has calculated on the basis of his experiments the horsepower required in surface currents to stop waves of given length and height. It was clear, however, to him and others, that tests on a large scale were desirable to ascertain whether large current horsepowers can be effectively produced in deep water, and whether the compressibility of the air bubbles at depths unobtainable in the laboratory would introduce hitherto unknown effects. The importance of increasing our knowledge of deep water behaviour was magnified by the reported success of open sea trials by Kurihara[4] in Japan.

With these questions in mind the tests described here were undertaken in August 1960 at the Trafalgar Graving Dock, Southampton. It was decided to limit measurements to current velocity, power and thickness for a large range of airflows, and not make waves in the dock. Before embarking on the work the need arose to investigate on a laboratory scale the effect on surface current of pipe orifice size and pitch, pipe arrangement (when two or more pipes are used), and the effect of air rich water on the performance of propeller type current meters. Tests were made by the British Hydromechanics Research Association, who have produced a report on their work[5]. It was concluded that orifice size and pipe arrangement are unimportant provided the desired quantity of air is discharged by the manifold, and that uniformity of discharge along it is readily obtainable at the air velocities and pressures visualised in the tests; current meters were found to operate satisfactorily.

The graving dock tests covered a range of airflows from 0·05 to 1·65 cusecs per foot of manifold, and horizontal currents were measured at up to fourteen stations, embracing the entire water depth from surface to manifold level. Four depths of water were investigated: 8·5, 17, 25·5 and 34-ft.; longitudinal and lateral traverses of the dock were made, and the behaviour of a porous pipe observed. Subsidiary information of scientific interest was recorded about the height and width of the bubble eruptions at the surface and the horizontal and vertical distribution of vertical current velocity in the air curtain. There was wide photographic coverage.

At the same time the current power and the power available in the air bubbles leaving the manifold were compared theoretically. It is suggested in section 2 that the surface current thickness does not increase in direct proportion to depth, but might vary logarithmically with a function of the depth and atmospheric pressure head, a relation which seems to be verified by the graving dock tests, but masked in laboratory work. The significance of this is that current powers predicted from model experiments are not fully realised in deep water.

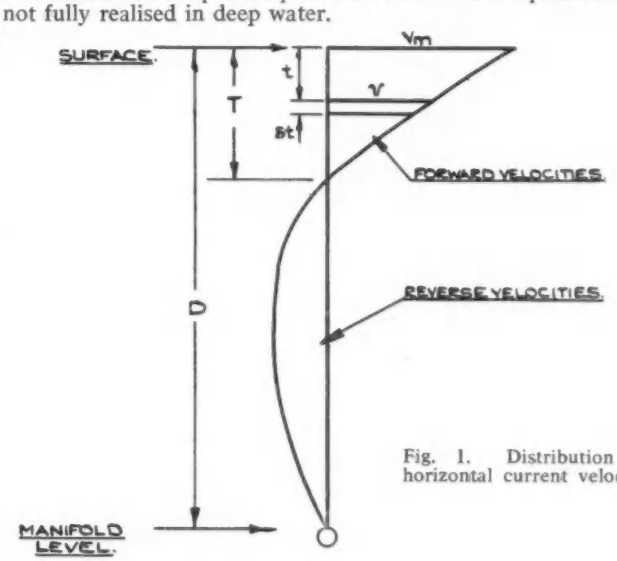


Fig. 1. Distribution of horizontal current velocity.

2. THEORY

(a) Surface Current Power

The distribution of horizontal current velocity over the depth from surface to manifold level, at a section far enough away from the manifold to be unaffected by vertical disturbance due to the air curtain is shown in Fig. 1. The velocity diminishes virtually uniformly from V_m feet per second at the surface to zero at depth T feet, then reverses. The forward zone is referred to as a surface current of thickness T feet.

Consider a section of this current width 1 foot, thickness δ t, depth t feet from the surface, where the horizontal velocity is v feet per second.

Weight of flow per second $= \rho v \delta$ lbs. per sec., where ρ is water density in lbs. per ft^3,

and energy of flow per second $= \rho v \delta t \frac{v^2}{2g}$ ft. lbs. per sec.

Total energy per second in surface current (i.e. surface current power)

$$= P_c = \frac{\rho}{2g} \int_0^T v^3 dt \qquad \text{ft. lbs. per sec.} \qquad (1)$$

If V is the cube root of the mean of the values of v^3 over depth T,

$$P_c = \frac{\rho}{2g} TV^3 \qquad \text{ft. lbs. per sec.} \qquad (2)$$

Suppose the quantity of **free** air supplied to the manifold is Q_0 cusecs per ft., at an atmospheric pressure H_0 ft. of water, and that the manifold is D ft. below the surface.

Total energy per second available in the air leaving the manifold, assuming isothermal conditions and a bubble pressure just sufficient to overcome the static head,

$$= P_A = \rho H_0 Q_0 \log_e \left[1 + \frac{D}{H_0}\right] \quad \text{ft. lbs. per sec.} \quad (3)$$

A comparison between P_c and P_A is of interest to the bubble breakwater designer. Remembering that there are two equal and opposite surface currents formed from a single bubble curtain, and taking the ratio of the powers as η,

$$2P_c = \eta P_A, \quad (4)$$

so that

$$TV^3 = \eta \, . \, H_0 \log_e \left[1 + \frac{D}{H_0}\right] \times gQ_0. \quad (5)$$

For a uniform reduction in v with depth, from V_m at the surface to zero at depth T ft. (see Fig. 5),

$$V_m^3 = 4V^3, \quad (6)$$

and if the quantity of air per second emerging from the orifices is Q cusecs per ft., equation (5) may be written

$$TV_m^3 = 4\eta \, . \, H_0 \log_e \left[1 + \frac{D}{H_0}\right] . \, gQ \left[1 + \frac{D}{H_0}\right], \quad (7)$$

(since $Q_0 H_0 = Q (H_0 + D)$).

Now Taylor[1], drawing an analogy between the vertical current produced in water by releasing bubbles and in air by releasing heat, has quoted the work of Schmidt[6] in showing that

$$V_m^3 = k_1 \, . \, gQ, \quad (8)$$

and model tests by Evans[3] and others corroborate this. The results discussed in section 4(a) below also give a relation of this form, the experimental value of k_1 being $(1{\cdot}46)^3$. Our tests also suggest over the range of depths in the dock, that

$$\frac{T}{H_0} = k_2 \, . \log_e \left[1 + \frac{D}{H_0}\right], \quad (9)$$

(see Fig. 12); the experimental value of k_2 is 0·32. Substituting in equation (7) gives

$$\eta = \frac{k_1 k_2}{4\left[1 + \frac{D}{H_0}\right]}, \quad (10)$$

so that the relation between Q_0 and current power $\frac{\rho}{2g} TV^3$ takes the form

$$\frac{\rho TV^3}{2gQ_0} \propto \frac{\log_e \left[1 + \frac{D}{H_0}\right]}{\left[1 + \frac{D}{H_0}\right]}, \quad (11)$$

later verified experimentally.

(b) **Current Velocity**

Taylor[1] discusses the case where T=0·28D. When this occurs, it can be deduced from equation (a), that D=0·27 H_0, and if η were taken as 1 (i.e. no energy losses), equation (10) gives

$$k_1 = (2{\cdot}5)^3,$$

that is

$$V_m = 2{\cdot}5(gQ)^{1/3}. \quad (12)$$

The experiments on vertical current in the bubble stream described in section 4 (b) show that the vertical current speed V_c is less than V_m when a $\frac{1}{4}$-in. orifice manifold is supplied with 1 cusec per ft. at a depth of 34-ft., the ratio $\frac{V_c}{V_m}$ being about 0·79. If this applies when $\frac{D}{H_0} = 0.27$, equation (12) becomes

$$V_c = 1{\cdot}97(gQ)^{1/3},$$

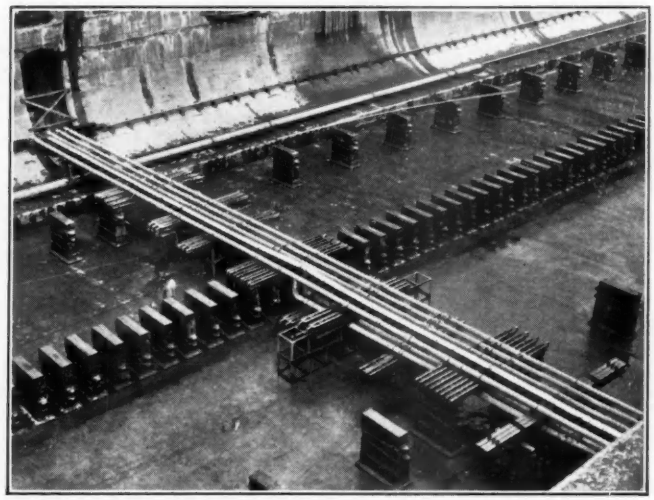
which is close to the experimental measurements of vertical velocity at a heat source quoted by Taylor[1].

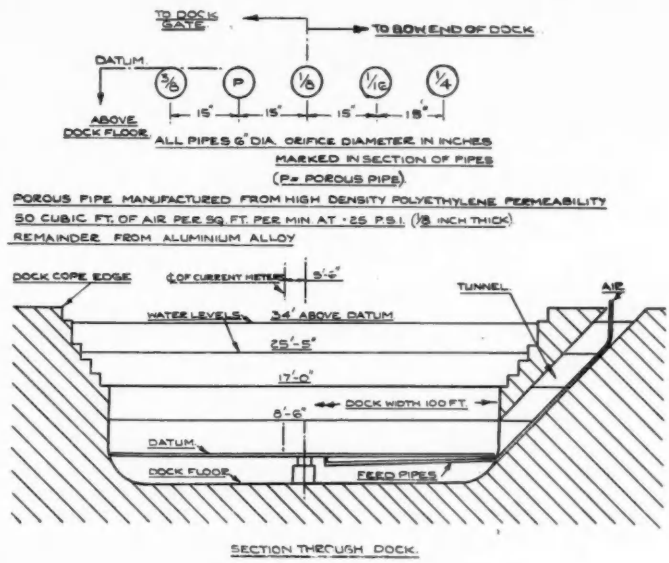
The experimental equation for V_m found in the graving dock tests is

$$V_m = 1{\cdot}46(gQ)^{1/3}. \quad (13)$$

3. TEST EQUIPMENT

The Trafalgar Graving Dock, Southampton, is 912-ft. long, 102-ft. wide between vertical sides, and can take a depth of water above keel blocks of about 36-ft. Fig. 2 shows a general view of the dock floor, with the pipe system crossing at keel block level 560-ft. from one end, and Fig. 3 gives details of the test





Figs. 2 and 3. Pipe details.

pipes. These were fed by 6-in. diameter pipes that passed down a tunnel in the dock side, joining them near the centre of their lengths.

As the maximum airflow required was far beyond the range of conventional portable compressors, a Rolls Royce "Nene" jet engine, modified by the National Gas Turbine Establishment so that up to 10,000 cubic feet per minute of free air could be bled from its compression chambers, was used. Fuel consumption was about 450 gallons of kerosene per hour, taken from a header tank fed by a bowser. The use of a jet in close proximity to dock terminal buildings set a silencing problem, which was successfully overcome by directing the exhaust through a Cullum Mark V detuner, passing the intake air through a splitter, and enclosing

the jet in a sandbagged engine house built from soundproofing material. (See Fig. 4.)

Air from the engine passed through an 8-in. pipe to a cooler, from there to a conventional measuring system of orifice plates and manometers and then to a small reservoir from which the five feed pipes emerged via gate valves. The air measuring and feed control point was connected by telephone to the engine control cabin, which housed the main air bleed valves, and no difficulty was found in keeping the supply constant for long periods. The complete air supply system occupied an area of about 250-ft. by 40-ft. on the dockside.

Fig. 4. Detuner, Engine House, Intake Splitter, Header Tanks and Bowser.

Trolleys, running on dockside rails carried a 140-ft. span Bailey bridge (Fig. 19) which could traverse the dock longitudinally. The bridge was constructed near the dock and lifted into position using a 200-ton crane. The centre of the bridge carried supports for a current meter gantry, which could be raised by means of a winch, and which was steadied at its bottom end by feet that rested on the dock floor. An adjustable frame on the gantry could take up to seven propeller type current meters, and by moving the frame vertically, the horizontal current could be measured at any number of vertical stations. Using additional frames and apparatus, horizontal current velocities could be measured at any distance across the dock, vertical velocities measured in the line of the main gantry, and check tests made on surface velocities and the depth of the current.

Because of the short period during the year when a dock of this size is available, work was continuous during the hours of daylight. All components were brought from various parts of England and Europe and the installation designed during a period of high pressure work between late May and mid July. The installation took six days to assemble and prove, and the test programme twelve days to complete. During a one day break in the middle of the programme the jet engine was serviced and inspected.

4. OBSERVATIONS

(a) Horizontal Currents

The orifice sizes and pitches were chosen so that by using each pipe in turn the full range of airflows could be studied. For example, the 1/16th inch diameter holes were only used for the 0·05 cusecs per foot flow, whereas the 3/8th inch holes and the porous pipe were used in the range 0·25 to 1·65 cusecs per foot. At all depths the $\frac{1}{4}$-in. diameter orifice manifold passing 1 cusec per foot was taken as a standard, and a longitudinal traverse of the dock using this manifold was always the first test to be made. These tests invariably showed that at a longitudinal distance D feet from datum the current had a steady maximum value, which diminished as the distance from the manifold increased. On this basis all subsequent tests, at a particular depth D feet were made with the meter gantry set at D feet from datum.

Early tests showed that conditions in the dock settled very quickly after a change of flow, and by the time the air flow had become stable current measurements could be taken. It was found that, although the current at any section fluctuated from minute to minute, the average of single counts lasting six minutes gave consistent results. Traverses of the dock indicated that, except at the extreme edges, the current speed and thickness was reasonably uniform, but this was not true in the case of the porous tube (Fig. 7). Here the surface eruptions were extremely variable, with large amplitudes near the end; this was probably due to the porosity being too low to cope with large flows; these

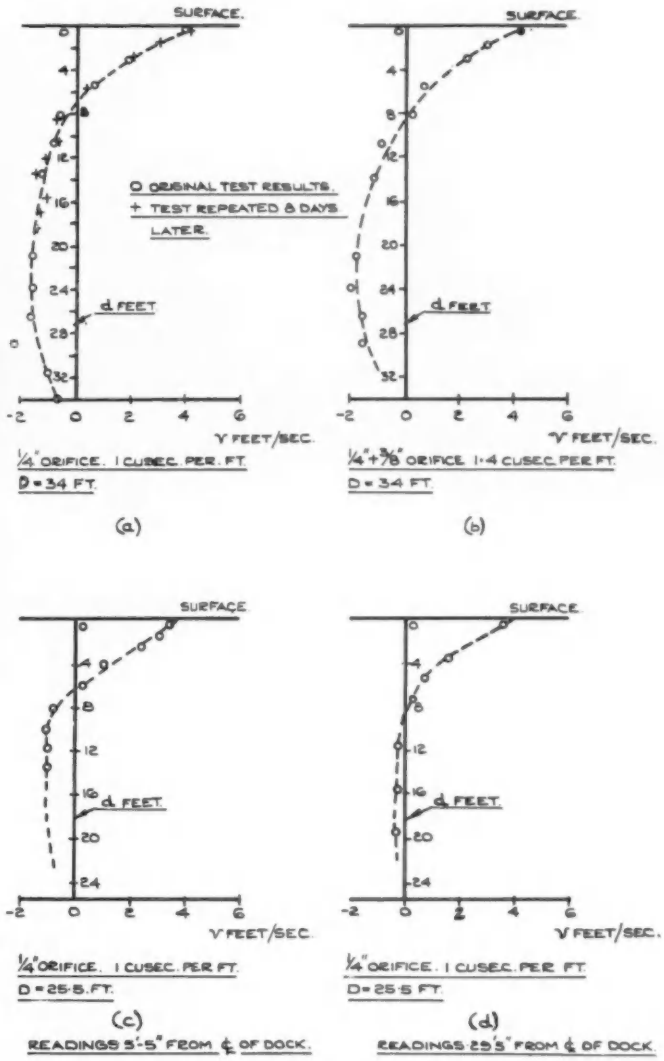


Fig. 5. Typical curves of velocity distribution.

would cause the end of the pipe to expand and let larger quantities of air through in that region. Because of the poor consistency of the porous pipe results they are not discussed in this report. After each test the profile of the horizontal current velocities was plotted, and the value of V_m and V^3T found. Typical profiles are shown in Fig. 5. For all flows and depths at D feet from datum the ratio $(\frac{V_m}{V})^3$ was within $\pm 2\%$ of 4, which is the figure for a uniform decrease of velocity with increase in depth (equation 6). When it became clear that the velocity profile was similar for all tests, the number of meter readings was reduced, and only the range from the surface down to $\frac{D}{2}$ covered. It was noticeable that at the section measurements were taken (5-ft. 5-in. from the

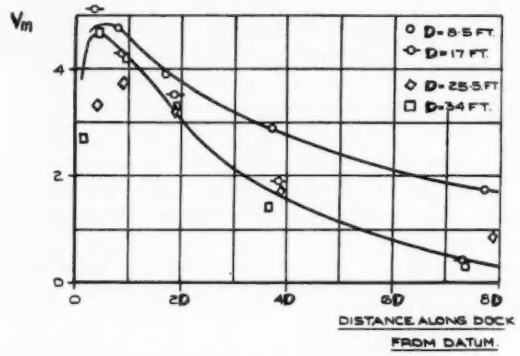


Fig. 6. Decay of surface current.

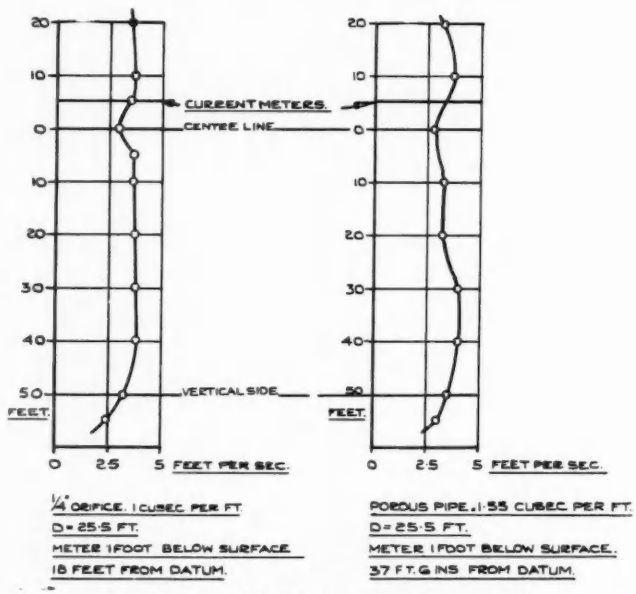


Fig. 7. Lateral distribution of surface current.

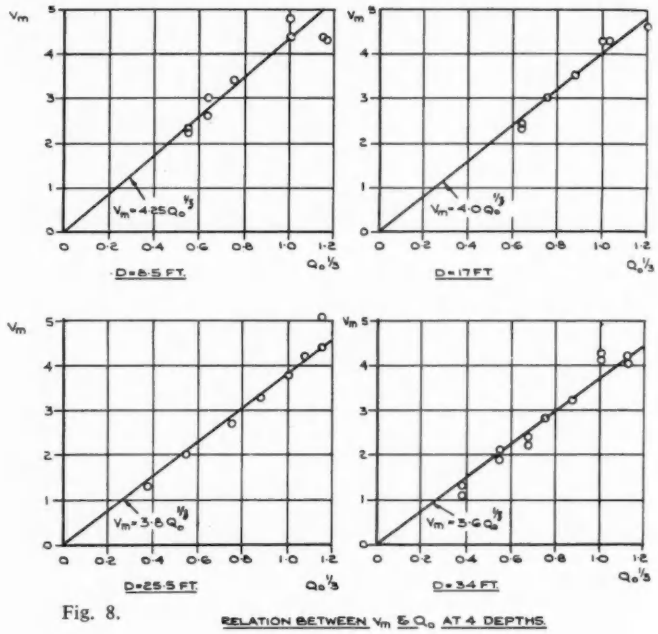


Fig. 8.

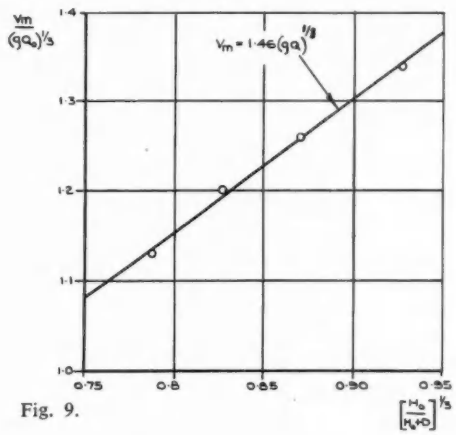


Fig. 9.

dock centre line) the quantity of water per foot width flowing in the reverse direction was often greater than that flowing in the surface stream. An explanation is that the flow in the return stream varied across the width of the dock, and this was verified by taking a profile 29·5-ft. from the centre line during one test. It was found, as Fig. 5(d) shows, that the reverse velocities were lower here, although the surface current thickness remained the same.

The current meters, manufactured by Amsler and Neypric, did not detect a reversal in current, but it was clear from the velocity plots which meters were in reverse. The meter coinciding with the change in direction of current always gave a false reading, as a minor fluctuation in the depth of the change would reverse the propeller, and instead of reading an average of zero it summed all readings. All meters were calibrated in the foreword direction at the National Physical Laboratory and in a reverse direction (where accuracy is not so important) at M.E.X.E. The current profiles shown in Fig. 5 take account of the reverse calibration. A separate check was made on the depth of reversal in one test (D=34-ft.), by means of a hinged flap operating electrical contacts, which was lowered vertically into the water at the end of a long rod. The average reversal depth on a lateral traverse was 7-ft., the average of all current thicknesses recorded by meters at D=34-ft. is 7·5-ft. (Fig. 12). Approximate checks were also made on surface current velocity V_m by timing the passage of floats dropped in the water just clear of the turbulent area. Floats were also used to investigate the pattern of surface current over the whole area of the dock, and the results are recorded in Fig. 14. Trouble due to breakdown in insulation in the meters, later traced to too high a voltage being applied, was rectified by changing to low-voltage counters midway through the tests. To ensure that earlier readings had not been affected by the higher voltage, provided the meters were counting, random tests were repeated. Fig. 5(a) shows that, as expected, there was no measurable difference in the results.

The test results for V_m and $Q_0^{1/3}$ are compared in Fig. 8.

Since $Q = Q_0\left[1 + \frac{D}{H_0}\right]^{-1}$, and since as Fig. 9 shows, the plot of $\frac{V_m}{(gQ_0)^{1/3}}$ against $\left[\frac{H_0}{H_0 + D}\right]^{1/3}$ is a straight line, it follows that a that a relation exists between V_m and Q independent of manifold depth. The form is:

$$V_m = 1{\cdot}46\ (gQ)^{1/3}.$$

When the same quantity of air is passed through different diameter orifices, there is no significant difference in surface current speed; also, the results for a single manifold blowing are not noticeably different from those when two manifolds are delivering the same total quantity. This confirms the model tests at B.H.R.A.[5]

Graphs of current power, $\frac{\rho}{2g}\ TV^3$ against Q_0 appear in Fig. 10. The results at D=8·5-ft. are wild and have not been plotted.

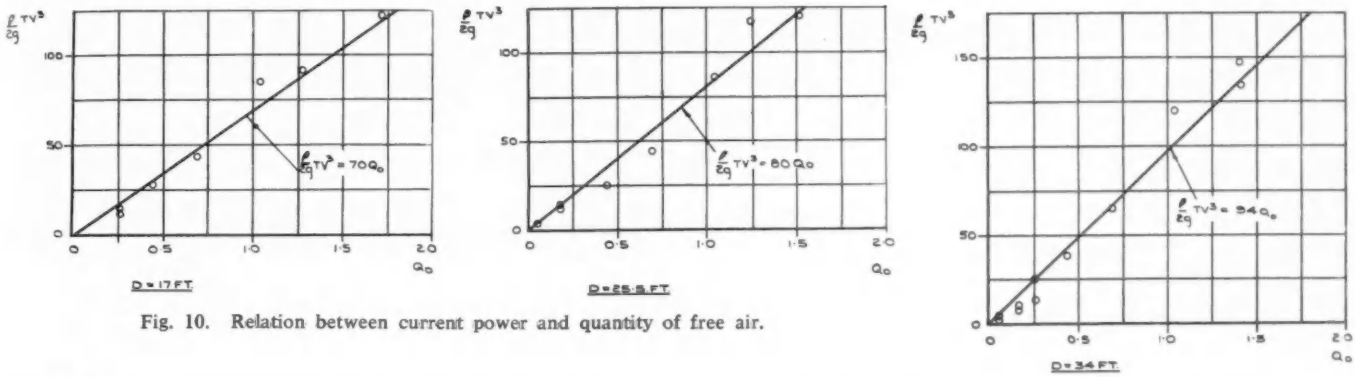


Fig. 10. Relation between current power and quantity of free air.

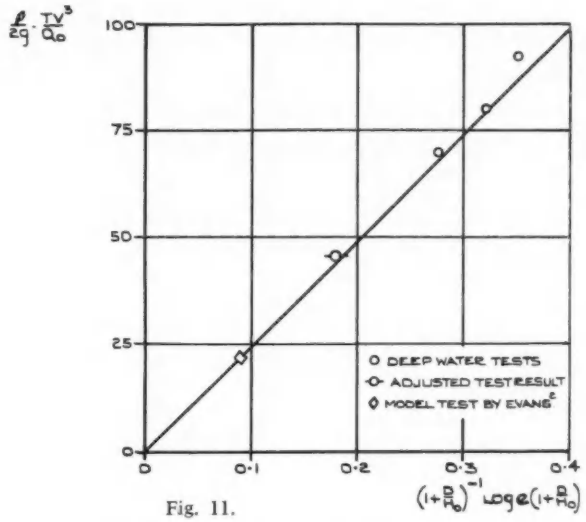


Fig. 11.

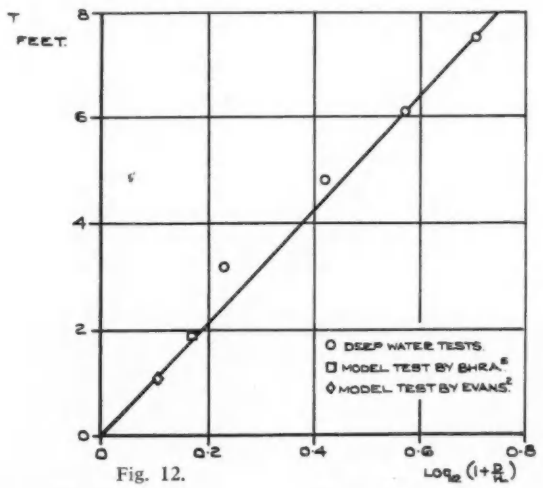


Fig. 12.

There are clearly outside factors affecting the readings at this depth, perhaps the proximity of the keel blocks and other dock floor obstructions, or even the motion of the body of water along the dock below manifold level. This discrepancy is also clear from Figs. 6 and 12, where the rate of decay of current and the current thickness are shown to be inconsistent with results at greater depths.

In Fig. 11, $\frac{\rho}{2g} \cdot \frac{TV^3}{Q_0}$ is plotted against $\left[1+\frac{D}{H_0}\right]^{-1} \cdot \log_e \left[1+\frac{D}{H_0}\right]$ as suggested by equation (11) in section 2(a). A calculation made from Evans model test figures [2] has been plotted on the same axis, and an adjusted result for $D = 8{\cdot}5$ ft. added (a current thickness compatable with Fig. 12 has been used). The test results confirm the theoretical form. Fig. 12, which also includes model test measurements, suggests a relation between thickness T and $\log_e \left[1+\frac{D}{H_0}\right]$ of the form $\frac{T}{H_0} = 0{\cdot}32 \log_e \left[1+\frac{D}{H_0}\right]$.

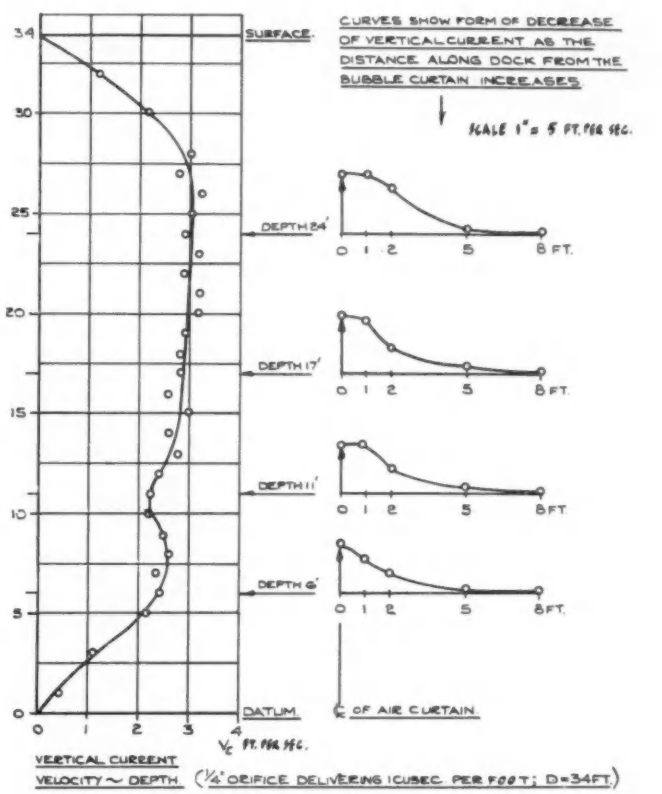

CURVES SHOW FORM OF DECREASE OF VERTICAL CURRENT AS THE DISTANCE ALONG DOCK FROM THE BUBBLE CURTAIN INCREASES
SCALE 1" = 5 FT. PER SEC.
SURFACE
DEPTH 24'
DEPTH 17'
DEPTH 11'
DEPTH 6'
DATUM
℄ OF AIR CURTAIN
VERTICAL CURRENT VELOCITY ~ DEPTH
(¼" ORIFICE DELIVERING 1 CUSEC PER FOOT; D=34FT.)

Fig. 13. Vertical traverses.

(b) Vertical Currents

When the depth D was 34-ft., a vertical traverse was made of the region of the air curtain, and the results appear in Fig. 13. Over the range 15-25-ft. above datum the velocity remained steady at about 3-ft. per second. This is only 72% of the measured horizontal surface speed at the same flow (¼-in. orifice, 1 cusec per foot), and 79% of the speed deduced from the experimental law $V_m = 3{\cdot}6\ Q_0^{1/3}$ for that depth. The velocity of the water increases as it changes from vertical to horizontal flow (later calibrations showed that current meters give identical readings whether vertical or horizontal).

Fig. 13 also gives the variation of velocity across the vertical current. Although there is a greater volume of water moving

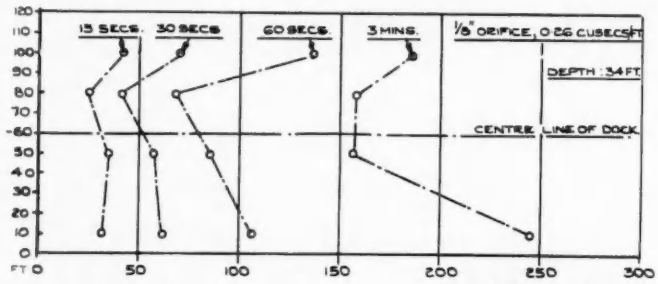


Fig. 14. Float tests.

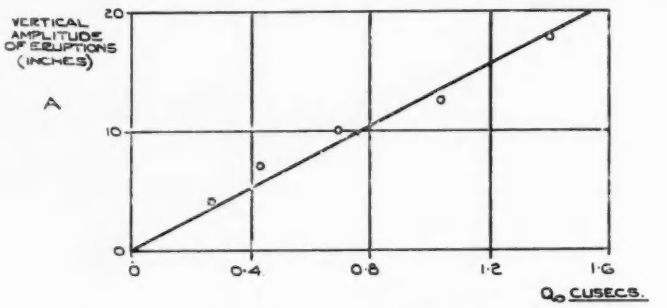


Fig. 15.

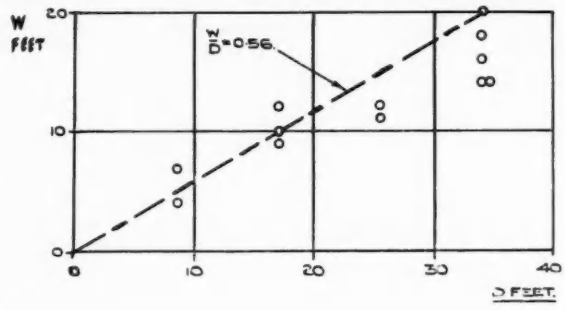


Fig. 16.

vertically 24-ft. above datum than at 6-ft. above datum, the width of the vertical current remains approximately the same at both sections. The width of the current near the manifold is greater than might be expected from Taylor's[1] analogy.

(c) Width of Turbulence at the Surface

A number of photographs (Fig. 19, 20, 21, 22) show the form of the surface turbulence. From these, and other observations, the width of the zone has been computed for a number of flows. Measurements were also taken of the maximum height above water level reached by the turbulence.

The apparatus for taking height variations is shown in Fig. 22. It consisted of a hollow tube, cantilevered from the dock edge across the air curtain, through which ran a wire cable. A heavy pointer was attached to the cable, so that it hung vertically over the turbulence, but was adjustable in height by winding in the cable. By marking the cable against a datum, measurements could be recorded. Figs. 15 and 16 show that eruption amplitude might be considered proportional to air flow over the range recorded and that the width of the zone is about ·56D at all flows and depths.

(d) The Path of Floats in the Dock

Floats were dropped simultaneously from the bridge, and after set periods their positions in the dock recorded (Appendix (e)). This indicated the form of flow at the surface, but gave no indication of conditions below. Generally, floats which were attracted to the wall of the dock moved fast, whereas floats in the centre

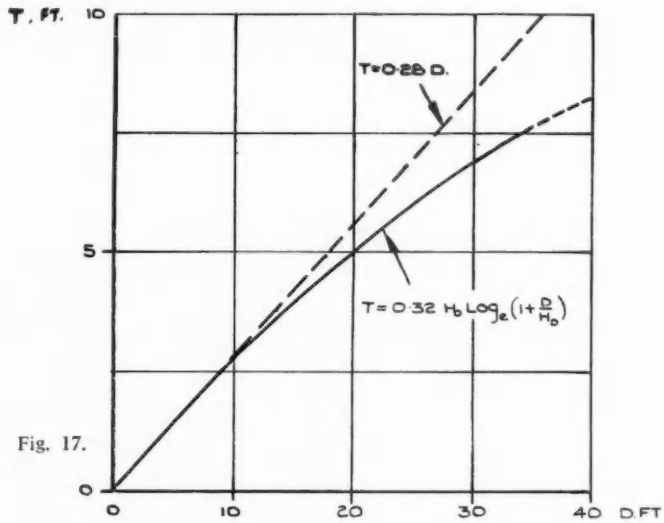


Fig. 17.

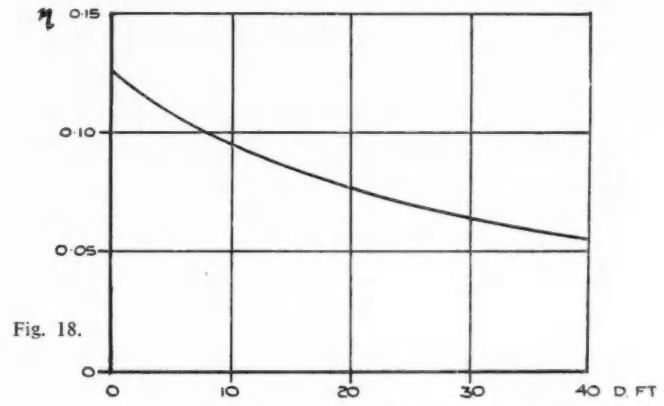


Fig. 18.

went quite slowly after traversing about 150-ft. There was no indication that the side streams turned inward and reversed at the end of the dock. Fig. 14 shows a typical plot obtained with floats.

5. CONCLUSIONS

(a) Current Speed and Thickness

The experimental relations between surface current velocity (V_m) and quantity of free air delivered per second (Q_0), and between surface current thickness (T) and depth of manifold (D) were expressed as

$$V_m = 1{\cdot}46\,(gQ_0)^{1/3}\left[1+\frac{D}{H_0}\right]^{1/3}, \qquad (14)$$

and

$$T = 0{\cdot}32\,H_0\,\log_e\left[1+\frac{D}{H_0}\right], \qquad (15)$$

where H_0 is the atmospheric pressure expressed as head of water.

Equation 14 agrees in form with the results of tests on a model scale, and with Taylor's analogy (with a modified constant), but equation 15 is a relation not hitherto found. Taking H_0=33-ft. (sea water), the variation of T with D is shown as the heavy line in Fig. 17. The dotted line is T=0·28D, which, although true in the range D=0 to 10-ft. (i.e. laboratory tests) does not apply in deep water.

(b) Current Power

From (14) and (15) above, the expression for current power is

$$\frac{\rho}{2g}\cdot\frac{TV_m^3}{4} = 0{\cdot}25\,\frac{\rho}{2}\,H_0Q_0\left[1+\frac{D}{H_0}\right]^{-1}\cdot\log_e\left[1+\frac{D}{H_0}\right],$$

and since $\rho H_0 Q_0 \log_e\left[1+\frac{D}{H_0}\right]$ is the power of the air leaving the manifold, the power ratio η is given by

Fig. 19. Trafalgar Dock, Southampton. View taken during tests. D=34, Q_0=1·41, ⅜-in. orifice.

$$\eta = 0{\cdot}125\left[1 + \frac{D}{H_0}\right]^{-1}, \qquad (16)$$

The variation of η with D is shown in Fig. 18. There is an energy loss between the manifold and the surface current that is apparently a function of the manifold depth.

(c) Bubble Breakwater Design

Evans[5], suggested values for the horsepower per foot run of wave crest required to (a) stop and (b) reduce the height of gravitational waves. For example, for waves of length L, height L/20, and surface current thickness L/10, the stopping horsepower is

$$H.P. = 0{\cdot}9\ L^{2{\cdot}5} \times 10^{-4}, \qquad (17$$

and to reduce their height by 50%

$$H.P. = 0{\cdot}27\ L^{2{\cdot}5} \times 10^{-4}. \qquad (18$$

(L/20 is a reasonable height for deep water waves, which do not generally exceed L/15 and become unstable and break at L/7; L/10 to L/25 is an efficient range for surface current thickness.)

Consider, for example, a manifold operating in 40 to 50-ft. of water, suitable for forming a breakwater off the South Coast of England. For waves 100-ft. long, 5-ft. high, the stopping current

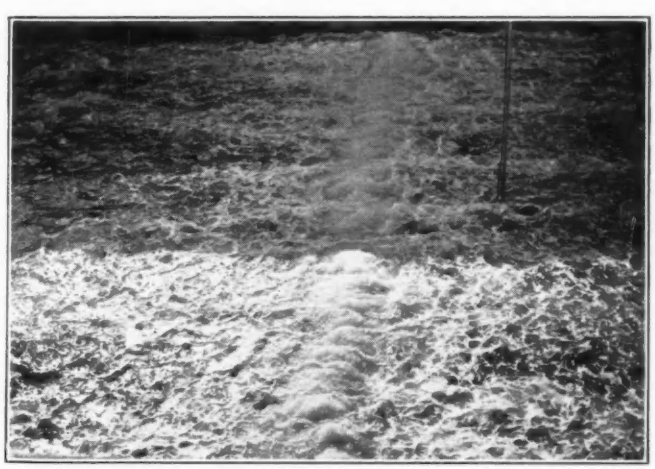


Fig. 21. Test 3. D=8·5, Q_0=1·61, ⅜-in. orifice.

Fig. 20. Test 12. D=17, Q_0=1·71, ¼-in. and ⅜-in. orifices.

power is given by

$$H.P. = 0{\cdot}9.100^{2{\cdot}5}.10^{-4} = 8{\cdot}9$$

when the current thickness is 10-ft. A manifold in 50-ft. of water, producing a current of this thickness (Fig. 17) at a current/air power ratio of 0·05 (Fig. 18) would require 179 h.p. per foot in the air. However, the unloading of large cargo vessels into lighters or amphibians might well proceed with waves 2·5-ft. high. To reduce the waves to this height calls for a current of

$$0{\cdot}27.100^{2{\cdot}5}.10^{-4} = 2{\cdot}7\ H.P.\ \text{per foot},$$

which corresponds to an air power of 54 h.p. per foot. This represents a quantity of free air of 15.3 cusecs per foot, which is equivalent to the full output of a Rolls Royce "Nene" of the type used in the tests for every 11-ft. of breakwater (it should be remembered that an air bleed jet is clearly not the most economic way of producing large quantities of low pressure air).

The above conclusions about power requirements are based on tests in the laboratory. Kurihara and others claim that factors not taken into account in Taylor's theory influence the wave breaking action in deep water, and have produced limited supporting evidence from open sea trials. There is now a need to carry out large scale work on waves under tightly controlled conditions with reliable measuring devices in order to set down authoritatively the behaviour of a bubble breakwater. The graving dock and B.H.R.A. tests have shown for the first time that orifice size and spacing and manifold arrangements are not influential factors and that the current thickness apparently varies logarithmically with a function of manifold depth; these import-

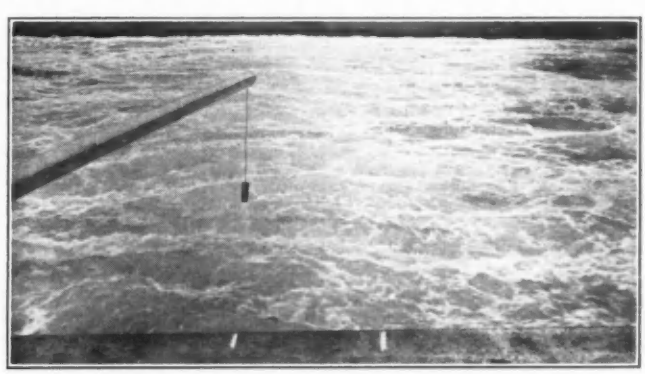


Fig. 22 Test 28. D=34, Q_0=1·41, ⅜-in. orifice.

ant facts have been discovered as the result of sound experimental technique, and enable a number of controversies to be set aside, but until large scale tests are made to investigate the remaining unknowns systematically, no proved basis exists for a theory usable by bubble breakwater designers.

Acknowledgments

The tests could not have taken place without the help of the British Transport Commission, who made the dock available at a nominal fee, and the National Gas Turbine Establishment, who loaned the air bleed jets and engineers.

The detuner was made available by the Ministry of Aviation and the bridge trolleys by the Royal Engineer Transportation Centre at Marchwood. The telephone system was installed by the Signals Research and Development Establishment.

It was most fortunate that Sir Geoffrey Taylor, Professor C. M. White and Mr. J. T. Evans were able to comment on the test programme and results. We are indebted to them for their interest and guidance at all stages.

The British Hydromechanics Research Association provided the air measuring apparatus and acted as consultants in the design of the manifolds.

The tests were carried out by the Military Engineering Experimental Establishment of Christchurch. The article is Crown Copyright Reserved.

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APPENDIX

TEST RESULTS

(a) Horizontal Currents at D feet along dock from manifold datum.

Manifold Depth D Feet	Test	Pipe	Q_o Cusecs	V_m Feet/Sec	T Feet
8·5	1	¼	0·98	4·75	2·75
	2	⅜	0·98	4·35	3·35
	3	⅜	1·61	4·30	3·20
	4	¼ + ⅜	1·56	4·35	3·10
	5	⅜	0·17	2·20	3·30
	6	¼	0·17	2·30	3·00
	7	⅜	0·26	3·00	3·80
	8	⅜	0·26	2·60	3·50
	9	¼	0·43	3.40	3·00
17	10	¼	1·04	4·25	4·25
	11	¼	1·27	4·25	4·70
	12	¼ + ⅜	1·71	4·60	6·00
	13	⅜	0·26	2·40	3·50
	14	⅜	0·26	2·30	3·50
	15	¼	0·43	3·00	5·50
	16	¼	0·69	3·50	6·00
25·5	17	¼	1·03	3·75	6·2
	18	⅜	1·24	4·20	7·0
	19	⅜	1·51	4·40	5·5
	20	¼ + ⅜	1·51	5·10	5·5
	21	1/8	0.053	1.30	6.5
	22	¼	0·175	2·0	6·2
	23	¼	0·17	2·1	6·2
	24	¼	0·43	2·65	5·5
	25	¼	0·69	3·25	6·0
34	26	¼	1·04	4·20	7·0
	27	⅜	1·04	4·10	7·3
	28	⅜	1·41	4·0	8·0
	29	¼ + ⅜	1·40	4·2	9·0
	30	1/8	0·052	1·05	6·5
	31	¼	0·054	1·30	5·5
	32	¼	0·17	1·90	8·7
	33	¼	0·17	2·10	6·0
	34	¼	0·26	2·40	7·2
	35	⅜	0·26	2·20	8·0
	36	¼	0·43	2·80	8·0
	37	¼	0·69	3·20	8·0

The porous pipe results were erratic and have not been included. Figure 7 show how V_m varied across the dock.

(b) Longitudinal traverses of dock (¼" orifice; Q_o = 1·04 cusecs in all cases)

Manifold Depth D Feet	Test	Distance From Datum Feet	V_m Feet/Sec
8.5	1	8·5	4·75
	1A	17	3·9
	1B	34	2·85
	1C	68	1·7
	1D	136	0·3
17	10A	8·5	5·1
	10	17	4·25
	10B	34	3·5
	10C	68	1·9
	10D	136	0·4

Manifold Depth D Feet	Test	Distance From Datum Feet	V_m Feet/Sec
25·5	17A	12·75	3·3
	17	25·5	3·75
	17B	51	3·2
	17C	102	1·7
	17D	204	0·85
34	26A	8·5	2·65
	26B	17	4·7
	26	34	4·2
	26C	68	3·25
	26D	136	1·4
	26E	272	0·4

(c) Lateral traverses of dock (current meter 1 foot below surface, D = 25·5 feet).

A = Distance from dock centre line in feet.

A	+55	+50	+40	+30	+20	+10	+5	0	-5	-10	-20
B	2·45	3·20	3·85	3·70	3·70	3·56	3·70	3·21	3·49	3·56	3·47
C	3·01	3·41	3·94	3·94	3·20	3·20	-	2·76	-	3·65,	3·21

B - Current velocity in feet/sec, ¼" orifice, 1 cusecs per foot
C - Current velocity in feet/sec, porous tube, 1·55 cusec per foot

(d) Vertical traverse of bubble curtain (D = 34 feet, ¼" orifice at 1 cusec per foot).

Distance Above Manifold (Feet)	Vertical Current Velocity Ft/Sec	Distance Above Manifold (Feet)	Vertical Current Velocity Ft/Sec	Distance Above Manifold (Feet)	Vertical Current Velocity Ft/Sec	Distance Above Manifold (Feet)	Vertical Current Velocity Ft/Sec
1	0·53	10	2·21	17	2·81	24	2·93
3	1·10	11	2·28	18	2·81	25	3·02
5	2·15	12	2·48	19	2·93	26	3.22
6	2·42	13	2·77	20	3·17	27	2·78
7	2·37	14	2·58	21	3·20	28	3·03
8	2·60	15	2·98	22	2·92	30	2·16
9	2·46	16	2·56	23	3·20	32	1·20

Distance Above Manifold (Feet)	Vertical Current Velocity (Feet/Sec) Distance From Datum (Feet) 1	2	5	8
6	1·76	1·06	0·25	0·16
11	2·51	1·25	0·30	0·07
17	2·65	1·33	0·38	0·15
24	3·00	2·31	0·22	0·15

(e) Float Tests.

(A = Lateral distance from dock centre line in feet to point where float entered water)

Test	A	Distance Travelled (Feet) After 15 Secs	30 Secs	1 Min	3 Min
28	-20	66	115	162	222
	0	45	79	132	202
	+20	64	105	153	202
	40	67	113	189	400
34	-40	42	70	137	185
	-20	25	41	68	158
	10	35	57	85	156
	50	32	62	107	245

Test	A	Distance Travelled (Feet) After 15 Secs	30 Secs	1 Min	3 Min
36	-40	48	72	103	199
	-20	37	58	104	199
	10	42	65	111	170
	50	45	80	148	263
37	-40	53	76	131	341
	-20	42	82	144	319
	30	45	94	103	-
	50	42	75	127	324

Photograph by courtesy Parkinson Howard Limited

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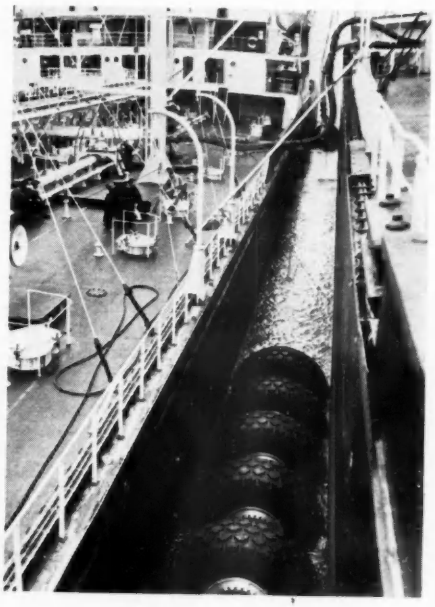

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Cross Channel Bridge . . .

Some Marine Problems

By Captain C. W. McMULLEN, D.S.C., R.N. (Retd.)

Introduction

The desirability of the countries of north-west Europe becoming closer linked economically and politically is accepted by most Europeans of good faith.

Soon France and Great Britain will be able to exchange electric power during off-peak hours, and in the last ten years close ties have certainly developed among the N.A.T.O. countries in the strategic field; in the civil engineering world we are witnessing the development of the Infrastructure Programme and realise that N.A.T.O. has a more solid core than certain "paper" alliances in the past.

Perhaps many advocates of the Channel Tunnel or Channel Bridge see such improved economic methods of communication as another tangible link. Might not the Tunnel or Bridge or both, play a real part in promoting north-west European unity, and once built, cement improved relations for all time?

The design of a tunnel is now far advanced and the fact that at least three outline conceptions of a bridge have been produced indicates that its construction may be feasible. But serious objections are bound to be raised due to its danger to shipping, and the bridge itself may be vulnerable to damage from ships. In this article an endeavour is made to examine some of these marine difficulties and certain strategic implications are also touched on.

Assumptions

When discussing these problems, it is convenient to make some assumptions about the imaginary bridge.

The outline scheme submitted to the Channel Tunnel Study Group has been used for guidance as follows:

Location—Between S. Foreland near Dover to a point just S.W. of Sangatte near Calais.

Distance between piers—1,200-ft. spans throughout.

The scheme submitted to the Study Group described a steel bridge with two pairs of navigation spans, each of 1,200-ft., with other spans of 740-ft. But it is of interest that the main span of the pre-stressed concrete Maraicaibo bridge, now under construction, is also 1,200-ft., and for simplicity this distance although probably uneconomic, has been used between each pier.

This would mean that for a length of bridge of about 18·2 sea miles, there would be ninety-one spans and ninety piers.

Steamer Tracks

It can be seen in Fig. 1 that ships steaming to or from the Western Approaches up or down Channel normally concentrate between the Varne Shoal and Dover, when bound to or from the major North Sea ports. This is due to the fact that a course close to the English coast is the most direct route for these ships and also an approach to the south side of the Dover Strait is unattractive due to the presence of the Varne, Colbert, Basurelle and Vergoyer shoals and also fishing fleets in winter. The flow of shipping on the south side is therefore very much less than on the north side, and marine problems which may arise near the French coast are not discussed in this paper.

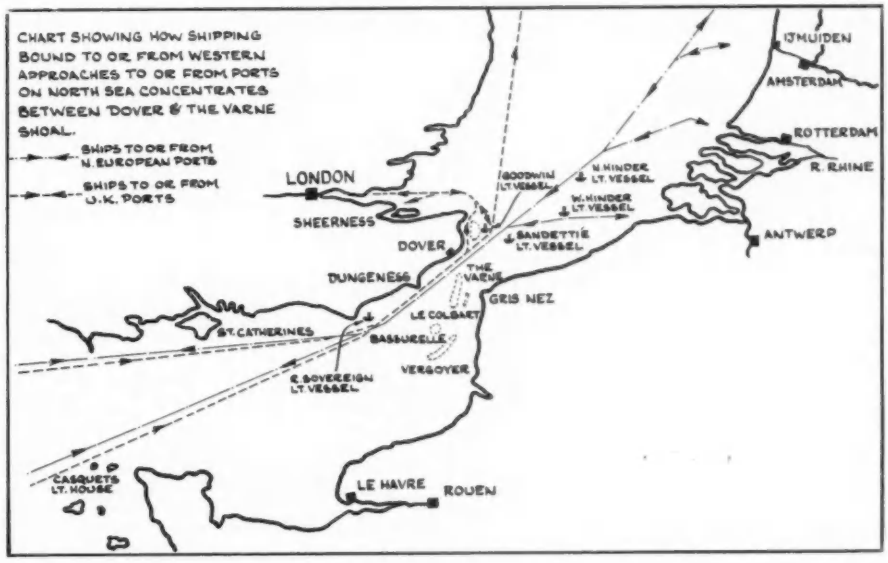

Fig. 1

Flow of Shipping

An indication of the amount of traffic to be expected between Dover and the Varne shoal has been found with the help of Lloyds Intelligence Service and by studying certain photographs of radar presentations.

In addition, south coast harbour authorities have helped with figures of coasters in and out of their ports via the Dover Strait.

Last year a total of 24,062 merchant ships were recorded by Lloyds Dover Signal Station passing in both directions within signalling range between Dover and the Varne shoal. Allowing about 27 days with a visibility under a mile and a total of 100 days with visibility less than 5 miles, it is reasonable to think in terms of a daily average through the year of about 70 to 100 merchant vessels.

But the flow varies and is higher in the summer, due to increased traffic between certain North European and North American ports. There are also days when navigation is greatly reduced due to poor visibility or stress of weather; there are other days when the flow may be decreased or increased due to labour considerations in particular ports.

Examination of radar photographs indicates that there have been occasions when the flow is considerably higher than 70 to 100. A radar Mosaic covering the English channel in July shows about 120 ships between the Casquets and Dover, other than those obviously bound to or leaving French

ports. Allowing an average of 12 knots, this indicates that perhaps 190 ships had passed Dover, or were about to pass in the immediate past and future 24 hours. (see Fig. 2).

hours though such a calculation covering a small area can be misleading.

To sum up, it is probable that the flow between Dover and the Varne shoal in both directions of all ships including warships

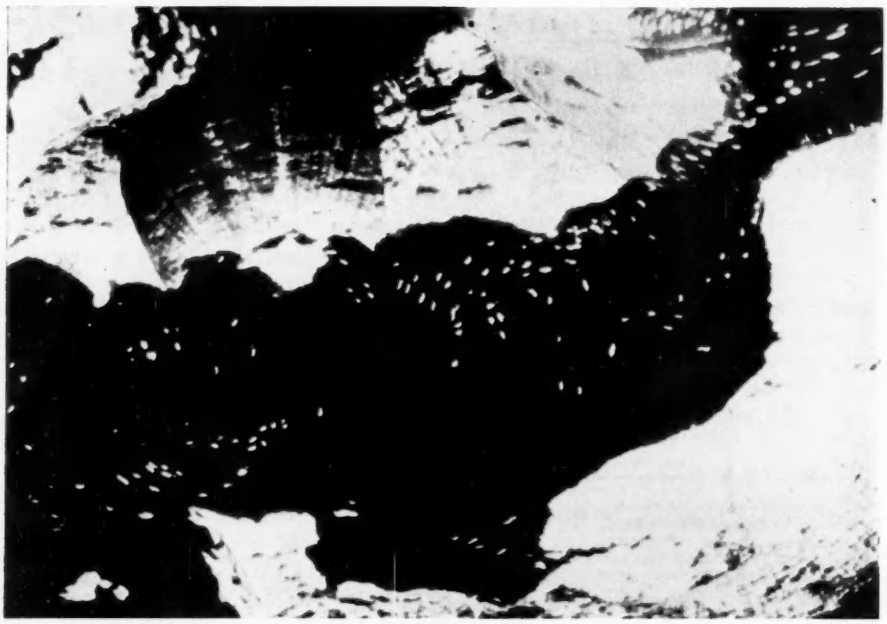

Fig. 2. Radar "Mosaic" showing about 120 ships between Dover and the Casquets, bound to or from Dover/Varne Channel. (Crown Copyright Reserved . . . Royal Air Force photograph.)

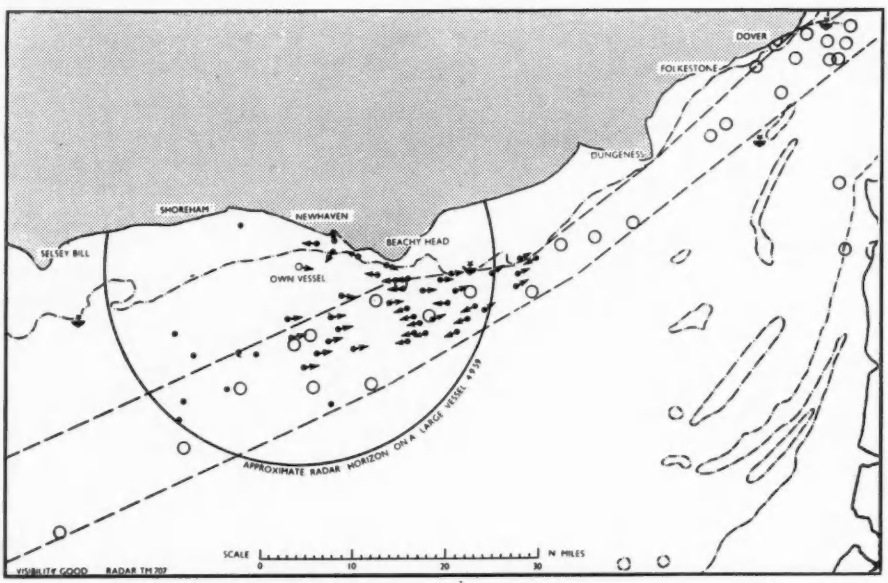

Fig. 3. o indicates positions of collisions in last 5 years.
• indicates position of a ship on radar screen.
Photo of Radar Presentation of Decca TM 707 showing concentration of 50 ships in Beachy Head area. (Published by permission of Decca Radar Ltd.)

Examination of another radar photograph indicates that in a forty mile area Dover/Beachy Head in January, there were 45 ships, a concentration which if maintained at twelve knots would indicate that about 300 ships would pass close to Dover in 24 hours. Allowing an average of 12 knots, this indicates that perhaps 190 ships had passed Dover, or were about to pass in the immediate past and future 24 hours. (see Fig. 2).

and fishing vessels (but not yachts) is normally between 80 and 120 ships a day and there may be occasions when it mounts to 200 or even more.

Of these, about one-third of the merchant ships will be under 2,000 G.R.T. and of the remainder about 16 per cent will be tankers.

There are also indications that year by year the flow is increasing both in numbers of ships and in total tonnage.

Density of Shipping

Eighty to a hundred and twenty ships every twenty-four hours, or three, five or even ten an hour, does not at first sight seem a heavy concentration for the five mile Dover/Varne channel.

Unfortunately they do not pass in a steady flow but in "surges," due to some extent to the tidal nature of the London Group of Docks. Ships enter or leave at times which vary according to the docks in question, the draught of the ships concerned and the range of the existing tides; but in general it can be said that the locks are used for shipping two hours each side of high water.

As a result many of the ships undocking keep in close company for the early part of their voyage; similarly ships inward-bound for London tend to bunch together as they adjust speed to time their arrival within 2 hours of high water; this concentration becoming prevalent as ships approach Dungeness for their pilots.

There are no restrictions on ships entering or leaving Rotterdam or Ymuiden (for Amsterdam) at any time and at Antwerp only the largest vessels have to wait for the tide, but due to ships "working" the tide through the Straits, concentrations of ships from and to these ports, especially low powered coasters are apt to occur.

Shipping "surges" are plainly illustrated in Figs. 3 and 4. These are photographs of the radar presentations of a Decca TM707 and TM46 respectively, taken during trials which will be referred to later.

In Fig. 3 a heavy concentration of about 50 ships can be seen in the vicinity of Beachy Head and in Fig. 4 two others are visible; one is in the Thames Estuary where about 35 ships are bunched together, while another lesser group is in the vicinity of Sandettie Light Vessel bound to or from Continental ports.

It is these concentrations of ships, often occurring in the narrow navigable channel south of Dover, which has made the area dangerous to all ships even though they may be fitted with the latest radio navigational aids.

Navigational Features of the Dover Strait

Shoals and Wrecks. As can be seen in Fig. 5, the Goodwins lie 4 miles N.E. and Varne shoal 5 miles S.E., of the Northern Section of the "Bridge" and the Channel through the Downs inside the Goodwins is used by medium and small sized ships. The waters South of the Varne shoal are not so frequented as those to the North.

Due to the presence of five wrecks S.W. of Dover, the big ship channel is at present reduced to 5 miles in width.

Tides. The Chart and Admiralty Pilot indicate a spring rate of 2·3 knots on the line of the "Bridge" in the middle of the Dover/Varne Channel, running for most of the time at right angles to the line of the Bridge.

About 4 miles east and north-east of the Bridge, however, there is a considerable amount of "Northing" and "Southing" in the direction of the tidal flow, and ships approaching the bridge from the north-east may experience a change in direction of the tide as the bridge is approached.

Visibility. As already described, the "Pilot" indicates up to 27 days a year fog, while a total of one hundred days with visibility less than five miles is normal. Captain F. J. Wylie, R.N., Director of the Radio Advisory Service (Chamber of Shipping), in his paper published in last year's October Journal of the Institute of Navigation, gives an average of 21·9 fog days per annum over seven years, with a maximum of 34·6 in 1953 and a minimum of 13·5 in 1957.

Cross Over Tracks. By referring again to Fig. 1 it can be seen that the tracks of vessels are often across one another. For instance a vessel from the Casquets en route London is bound to cross the track of a ship from St. Catherine en route Rotterdam. A vessel steaming from Antwerp to Southampton is bound to cross the track of a ship en route Casquets from Hamburg, and so on.

Much of this crossing of tracks occurs before or after passing Dover, but some actually in the vicinity of Dover where in the Dover/Varne Channel, steamer tracks are not necessarily exactly parallel.

In addition, the Cross Channel packets cross the main steamer tracks at broad angles.

Fishing Activities. Large scale fishing activities take place in November, December and January on the south side of the Dover Strait in an area bounded roughly by Sandettie Bank, Gravelines and Calais. Numbers of vessels involved during these months may total 60 British and 300 Foreign, both trawlers and drifters. The largest concentrations will be in November and December, notably south of Sandettie Bank and inshore between Calais and Gris Nez.

Accidents in the Dover Straits

Stranding. Figures are only quoted for vessels going aground on the Goodwins and Mr. B. L. Cloet of the Admiralty Hydrographic Department has kept an unofficial record of these incidents apart from those which took place during the war.

A total of 27 ships have gone aground, of which 6 were total losses, in the last thirty years. Admittedly many of these were shortly after the war, when ships used to travelling in convoy were not yet fully conversant with the newly-placed navigation marks. It is encouraging that since 1946 only five ships are known to have run aground on this danger and the fitting of radio aids has no doubt helped considerably.

Nevertheless, it must also be remembered that these shoals, situated as they are, only 4 miles eastward of the "Bridge" must always contribute to the "unattractiveness" of the area from a navigational point of view and that quite recently a large passenger liner, fitted with all navigational aids, grounded there.

Probably the most interesting lesson to be learnt is that on only one occasion has a pilot been held to blame for a stranding on the Goodwins, an indication no doubt that local knowledge is invaluable where navigation in difficult waters is concerned.

Collisions. Two notable studies have recently been made which consider the incidence and causes of recent collisions at sea.

The first was the subject of a paper on the "Statistical Analysis of Collisions related to Locality," delivered by Mr. J. H. Beattie (of Decca Radar Ltd.) to a combined meeting of the British and German Institutes of Navigation. This resulted from an operational research programme undertaken by "Decca."

The second was the paper by Captain Wylie already referred to.

After examining these studies, the following facts appear relevant:

Between 1955 and 1960, in a sample of 360 collisions which occurred to ships over 200 tons in N.W. European waters, about one-third appeared to involve ships in which neither ship was fitted with radar.

It is known that 40% of the disasters took place in bad visibility and 2% in clear weather; the condition of visibility in the remaining incidents is unknown.

Fifty-five per cent took place in the approaches to 9 major ports, and 32% in main traffic routes or near focal points.

Of the latter it has been discovered that at least 4 collisions took place within 15 miles of the "Bridge" in 1959 and 7 in 1960. On going to press 3 have occurred in this area in February and 3 in March 1961.

In other words in just over 2 years, at least 34 ships have been involved in collisions close to the assumed site of the "Bridge."

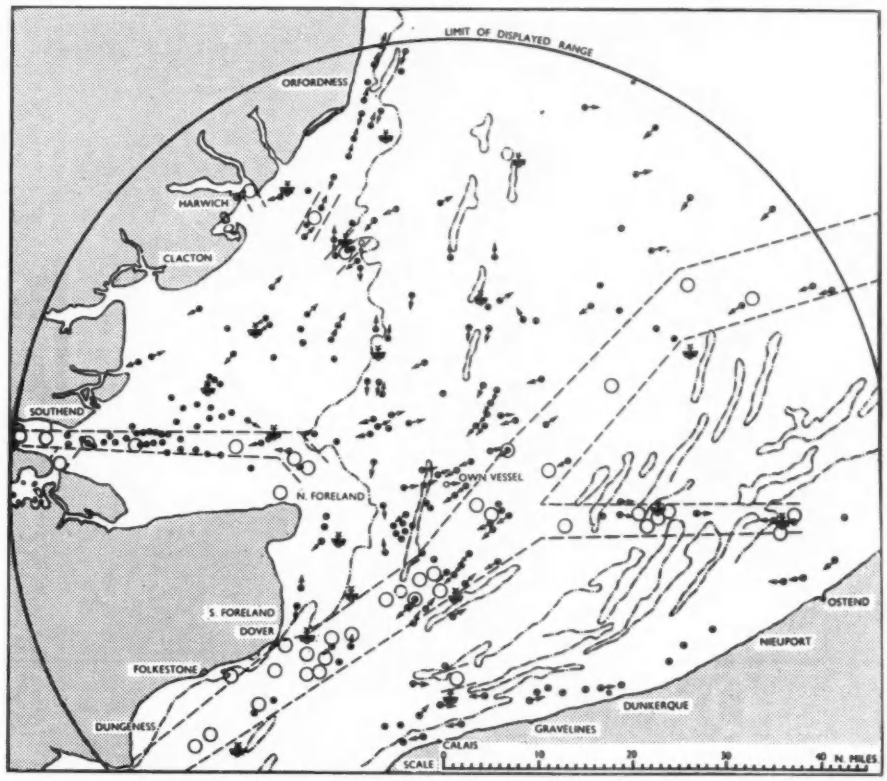

Fig. 4. o indicates positions of collisions in last 5 years.
• indicates position of a ship on Radar Screen.
Photo of Radar Presentation of Decca TM 46 showing concentrations of ships in Thames Estuary and south of "Own Vessel". (Published by permission of Decca Radar Ltd.)

General Accident Trends

The introduction of radar and hyperbolic position finding radio aids helps ships to keep under way, in conditions of bad visibility; before the introduction of these aids, days might have been spent at anchor in fog conditions, but now a ship's late arrival in similar conditions is considerably reduced.

Her radar set will have given her excellent fixes off Dover where the land and breakwaters are clearly defined, and her "Decca Navigator" should enable her to plot her position, probably to an accuracy better than 200 yards.

But although the introduction of radio aids has paid great dividends in the economic running of ships, and especially the big ones, there have also been disadvantages.

Due to modern accuracy of navigation, ships are apt to stick to "Tram-Lines" with a possible tendency to proceed at higher speeds in bad visibility than would otherwise seem prudent.

As a result the number of collisions per year has not noticeably decreased. One figure studied shows the rate as steady while another, a slight increase; but whatever the trend, the rate is a cause of some concern, and that described in the vicinity of Dover is of particular interest.

Also, apart from the fact that the accident rate shows little or no decrease, the collisions when they do occur, may be catastrophic in nature due to the fact that certain classes of ships, notably tankers and ore carriers, are getting bigger. The increase in size especially among the large single screw ships may also contribute to accidents, due to their being less able to make a bold and rapid alteration of course in restricted waters.

Recent Investigations and Papers

Apart from the two papers and operational research already described, Capitaine de Fregate L. Oudet has written a paper entitled "The Separation of Traffic at Sea," which is published in the January 1961 Journal of the Institute of Navigation together with a note on the Channel Bridge.

In the same issue, Captain J. Poll contributed a paper on "Traffic in the Dover Strait" with suggestions for routing traffic in separate lanes and improving safety.

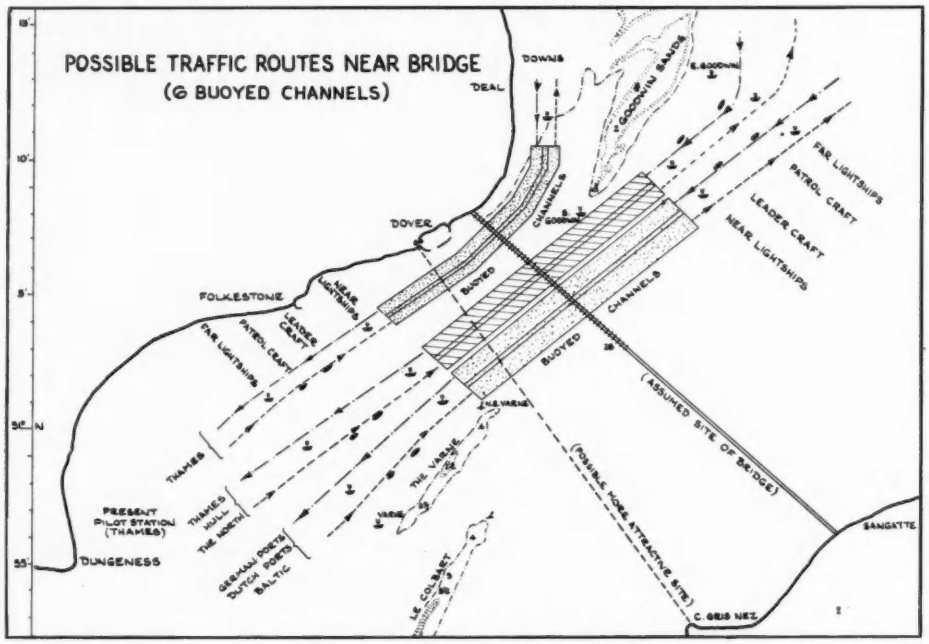

Fig. 5

In 1960 a Safety of Life at Sea conference was held in London attended by representatives of 56 countries, and anxiety was expressed at the present accident rate of collisions at sea, having regard particularly to the introduction of radar. In fact an annexe to the International Regulations for Preventing Collisions at Sea was produced, giving advice on the use of radar, and although not yet ratified by all nations, it has been agreed that it should be brought to the notice of mariners immediately.

It is therefore true to say that, even without a large obstruction being planted in the Channel, there is already anxiety in international shipping circles due to the present number of accidents which occur to ships throughout the world in general and the Dover Strait in particular.

Effect on Shipping of Building Bridge

Most seamen would describe the twenty piers that shipping would have to negotiate in the Dover/Varne Channel as menaces to navigation, situated as they would be in the open sea in the busiest sea lane in the world.

However well they were "lighted," fitted with radar reflectors, "lead-in" buoys and synchronised fog signals, they would have to be navigated by an endless procession of ships of all sizes in all states of wind and visibility.

Furthermore we have seen that ships might arrive at the Bridge, not in an orderly procession, but possibly in concentrations. However one looks at it, the Bridge would restrict manœuvre in an area which is already considered hazardous.

In the section on Assumptions, the most favourable conditions were adopted by making each span 1,200-ft. instead of retaining the Navigation Spans which would automatically increase the "Tram-Line" effect and restrict ships to a 2,400-ft. wide "Road."

If ships were free to select any arch, however, even graver difficulties might result. In such circumstances the thought of three ships approaching the Bridge from one direction and three from the other all of which were anyway bound to pass close to one another, is not a pleasing one; added to which it might be thick weather, blowing a gale, with one ship not fitted with radio aids and another with its radar out of adjustment; perhaps a third would be a hard pressed small coaster having difficulty with her steering. Such a situation would obviously be unacceptable and it would be necessary to establish some system of shipping control.

But it is believed that the control system established, would not only have to be capable of directing the sort of situation described above, but would have to be so efficient that an improvement over the present accident rate would result, **even after the bridge is built.**

For the Bridge would not be like the Suez Canal, which is of great economic value to most maritime nations; the Bridge would only be of real benefit to three or four countries.

What would be the reaction of the countries who use the English Channel but had no economic interest in the Bridge?

An arbitrary declaration by the U.K. and France of an increase in the three mile limit to twelve miles is discounted, but countries would still consider the Bridge interfered with the traditional freedom of manœuvre at sea and this is especially likely if an efficient form of shipping control was set up.

And this system might be unpalatable,

not only to those not interested in the Bridge but to Great Britain herself, who with 14% of the world's shipping, still operates the greatest merchant fleet. For to get a control system accepted by all countries on a world sea route, it would presumably have to be internationally operated, perhaps by U.N.O.

But as already stated, it is believed that its only hope of acceptance would be if it could be proved that its adoption would prove so beneficial, that the accident rate would decrease, even after the Bridge was built, and in spite of the likely continued increase in numbers and tonnage of ships using the Channel.

There would be another obvious factor; the building of the Bridge would have to impose no extra cost to shipping, due to delays, extra insurance rates or pilotage fees.

It is not encouraging to read that shipping using the St. Lawrence Seaway is now facing a possible large increase in insurance costs due to the high accident rate on the Seaway.

Would it be possible to devise a control system to satisfy the requirements of safety combined with no extra expense to shipping? At a price most things are possible; but it is believed that the cost in this case would have to be borne by the Bridge authorities.

Safety of the Bridge

The thought of some twenty or more ships in collision every two years, in the vicinity of the Bridge conjures up the unpleasant possibility of a monster tanker, in collision, stopped and on fire, held by the tide across one of the piers. With the present accident rate and the increase in size of tankers, this is not such a fantastic picture; the effect on the Bridge might or might not be catastrophic, but there might also be an additional hazard when nuclear propulsion in merchant vessels comes into being. Also large single screw ships in ballast in heavy weather, may be unable to reduce speed when negotiating the Bridge, and with the present accident rate, it is possible over a period of years that one might ram a pier head on.

We have seen the effect of a very small ship colliding with quite a large bridge and another small ship at Sharpness, where two spans were brought down and many lives lost; admittedly the Channel Bridge piers would be very massive structures, but by no stretch of the imagination could a 60,000 ton ship do the Bridge any good if she hit a pier at sixteen knots, and loss of life might also be great.

There would be other dangers to the Bridge apart from the normal continuous traffic; ships in tow would often have to negotiate it, sometimes in bad weather, and a large floating dock or off-shore drilling rig would also occasionally be towed through it.

It is suggested that the control system would not only be responsible for the safety of shipping, but also for the safety of the Bridge itself.

Possible Principles of Control

The arguments in this paper have so far, it is believed, been based on facts, but to indicate the sort of control system required, it is necessary to enter the world of theory. For it is believed a revolutionary system of shipping control in the Dover Strait, and its approaches, would be essential to meet the requirements of shipping and bridge safety.

To work out such a system a complicated study is required and once completed, there would be no guarantee that the system would work in practice, unless a trial period was possible; a pertinent point when underwriters consider the effect of the Bridge on insurance premiums.

But to give an indication of the sort of steps necessary, the writer ventures to suggest the following:

(a) Establishment of International Control Organisation (I.C.O.).
(b) Introduction of I.C.O. Compulsory Bridge Pilotage System.
(c) Introduction of Compulsory Routing System with Special Navigational devices and marks.
(d) Setting up of North and South Control Stations.
(e) Establishment of Auxiliary Craft.

International Control Organisation (I.C.O.)

Simplification would obviously result if the members consisted of France and Great Britain only. In the present world climate, however, with the increased interest of Russia in world trade, and the interest of every maritime power in the English Channel sea route, it is likely that every maritime country would have to be represented. We are then faced with yet another complicated political "set-up" but although difficult, it should be possible to create such an organisation.

Pilotage

The bridge would make pilotage compulsory for all ships using the Dove/Varne Channel; it is already in the London Pilotage District and ships for ports in this district embark pilots off Dungeness. These might become dual Bridge and Thames pilots, but it would be necessary to evolve extra pilot stations for the greater part of the shipping bound to or from other North Sea ports.

At first sight it appears that pilot craft might patrol the waters at the entrance to the bridge "lead-in" channels described later. But one of the main dangers to shipping will be ships "crossing over" before these channels are entered and for this reason pilot stations might have to be further afield, perhaps in the Isle of Wight and Alderney areas; eastward of the Bridge the problem might be more complicated.

It might be possible for certain ports like Rotterdam to provide dual role bridge/port pilots and there might be some relaxation in the embarkation of pilots where coasters are concerned, though it must be remembered that it is these ships who may lack radar; furthermore in bad weather, they may find it difficult to conform to routing instructions.

Compulsory Routing System

As already stated, Capitaine de Fregate L. Oudet and Captain Poll have suggested routing traffic in certain lanes to improve existing safety.

In Fig. 5 an indication is given as to how certain lanes might be established at the Bridge itself.

As it is assumed that all spans certainly in the Dover/Varne Channel will be "Navigational" and 1,200-ft. in width, a ship travelling down a one-way lane would have the choice of three or four spans. Further separation of ships inside each one-way lane, would be achieved by pilots of fast ships keeping to the starboard hand arch; slow ships and those being "lead" in thick weather would keep to the port hand arch.

In the figure, 3 routes are shown in the Dover/Varne Channel and other routes would, no doubt, be established south of the Varne shoal; the entrance to each route is shown as being marked by a near and far lightship.

Each route is separated into a west going and east going channel, each being separated by a span width and each being well buoyed.

In thick weather, leader navigational craft would be required to lead ships not fitted with electronic aids or with these aids unserviceable.

But it would still be necessary for a very complete system of navigational lights, fog signals and radar reflectors to be fitted to each bridge pier and the lead-in channel buoys and lightships; furthermore some of the existing wrecks would require removal.

The fitting of fog signals to the piers would involve the use of synchronisation and different types of signal; perhaps the siren for west-going arches and the reed for east. The fitting of radar reflectors to the piers might also require special study as examination of a radar presentation of the Forth Bridge has shown that with its massive steel superstructure, the piers do not show up clearly.

Once in the lead-in channel at the outer lightships, no crossing over would be permitted.

Examination of Fig. 5 will show that there might be advantages to shipping, if the bridge was sited more to the west.

North and South Control Stations

Once the bridge was built it would be logical for the control stations to be situated on the bridge itself where good radar and radio conditions would be obtained.

A certain amount of co-operation between the "control" and shipmasters might result in a steadier stream of shipping at the Bridge than at present occurs in the Dover/Varne Channel; this might conceivably also be achieved at the pilot stations where there is always danger of a "pile-up" in thick weather.

For instance, a ship entering the English Channel from the westward bound for Hull might report her position and speed off Ushant and then be advised when the outgoing London "stream" would be passing the Bridge; it might then be worthwhile for her to adjust speed to avoid this.

One difficulty the control would be faced with, is voice communication and identification; if a large number of ships were present several voice frequencies would be necessary entailing quite an extensive radio installation; who would pay for this if not fitted voluntarily?

If a "leader-craft" is required to lead a vessel in thick weather, how would the vessel being escorted keep in touch with her guide? Voice communication would be essential and the pilot in the ship following astern would have to comply with the instructions from the "leader-craft" pilot; a robust portable R/T set might become an essential part of a "bridge pilot's" kit.

The identification of craft would also prove a problem; one method sometimes adopted is for a ship to "swing" and the control to thus pick up her radar "blip." But this might be undesirable in crowded waters and especially where large vessels are concerned.

Accurate radar navigation would allow identification by the reporting of positions, though there would be a time lag; reporting when passing the outer lightship would provide another method, but perhaps the most certain would be for patrol craft to contact each ship before entering the "lead-in" channel and report its position; the control keeping each of its own patrol and leader craft continually on its plot.

Auxiliary Craft

To prevent accidents, strict traffic discipline would be necessary and for this reason it is believed that patrol craft would be required, not only to check that pilots are on board, and if not, possibly to put one aboard, or turn a ship back. Furthermore in thick weather it must be checked that a ship's R/T link and radar are working and if not, that she is taken in hand by a "navigational leader" before being allowed to proceed.

As already explained patrol craft might also be required to help the main control station in identifying craft.

It might be argued that the "leader" craft are unnecessary and that ships without radar with pilots aboard could be conned in thick weather from the main control station's radar.

This might be so if voice communication and identification were perfect, but if the ship is not fitted with radio aids she may not be fitted with the necessary voice communication and the "navigational leader" will look after these ships in thick weather using the pilot's short range voice R/T set.

In addition to the craft described, a duty ocean tug would have to be on immediate call, probably in Dover Harbour, to deal with any sudden emergency in the vicinity of the Bridge.

Period of Bridge Construction

It would be necessary to establish the control organisation before construction started, as a stricter form of shipping control would be required during the difficult period of building than actually after the bridge is completed.

The method of construction would of course have to take into account the dangers that might result to ships and to the temporary works themselves and the control and routing organisation would require adjustment and modification in accordance with the construction programme.

As construction across the five-mile Dover/Varne Channel would presumably take about five years, this difficult period might be even more unacceptable to the countries not interested in the Bridge than the final establishment of the Bridge itself.

Cost of Control System

If it is accepted that the building of the Bridge must not involve shipping in any extra expenses, the cost of the control organisation, with its headquarters staff, pilots, buoyage and auxiliary craft must undoubtedly prove a heavy item when the economics of the Bridge are examined.

Perhaps some minor relaxation might develop here, if some of the control methods suggested are adopted in the future, regardless of the Bridge, in an endeavour to reduce the present accident rate in the English Channel.

Strategic Implications

The dangers of opening the country to onslaught and robbing us of our island status have always been stressed by adversaries of the Bridge or Tunnel. Certainly if the country ever again faced invasion the thought of 90 "pill-boxes" stretched across the Channel, even after the Bridge had been "dropped," is not a pleasant one; the destruction of the Bridge might also affect the navigability of the Dover Strait.

There are, of course, other well known strategic issues. There can be little doubt that if the Bridge was built it would be used so extensively that it would become a vital "jugular vein" and other methods of cross channel communication would be reduced and some might even disappear.

Conclusion

As a sailor, the writer of this paper admits to being instinctively biased against a Bridge. Nevertheless it is believed that the facts and arguments propounded are reasonable. If the Bridge was designed to serve the whole of mankind, most of the difficulties described could be overcome; but this is not so, and encroaching as it will, on one of the busiest shipping lanes in the world, it is likely to be bitterly opposed by those whose livelihood depends upon freedom of navigation.

Acknowledgments

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Association of Supervising Electrical Engineers' Year Book and Technical Guide 1960-1961. Published by Fraser Pearce Ltd., Brighton, Sussex. Price 5s. post free, 216 pp., 25 tables.

The 10th edition of this Year Book has been completely revised and new material incorporated in the technical section which has been brought up to date with current developments. Together with previously published technical data—tables, formulae, definitions, etc. — to which the electrical engineer may wish to make constant reference, there are notes covering oil-burner controls, electrical motor control gear for applications imposing fire hazards and choosing metal rectifiers.

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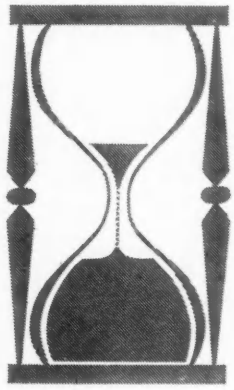
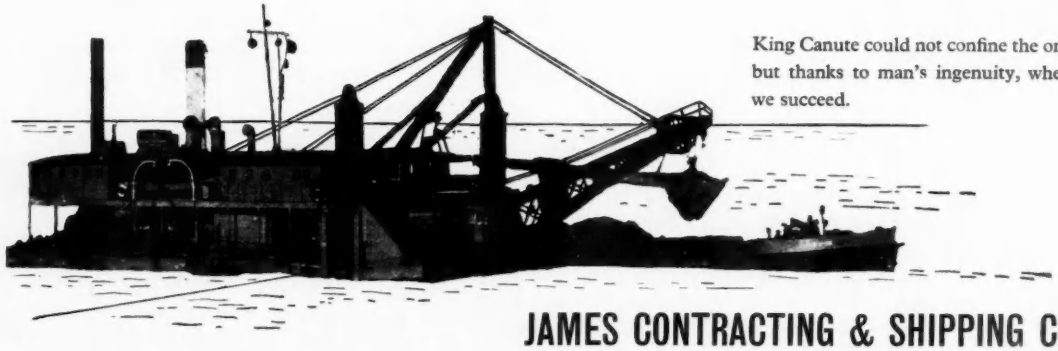
Canute reproving his courtiers at Southampton, from a painting by Lorentz Frolich.

"Nae Man can tether Time or Tide"

The poet's words are as true today as they ever were, man still pits himself in endless war against the sea. Man cannot relax in this struggle — though he sleeps the sea never rests — the tide rips ceaselessly at the sea wall — rivers carry their burden of silt to the estuaries, — winter winds and tides bring mountainous seas that flood the land, and leave desolation in their wake. To tether the tides and tame the sea — reclaim the land and keep harbours and channels clear, potent tools are needed — we can provide these tools — together with the skills gained during many years of unremitting war against the sea in all parts of the world.





King Canute could not confine the oncoming tide, but thanks to man's ingenuity, where he failed, we succeed.

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AP16

The Control of Imported Meat

Food Hygiene Regulations Applicable to Docks

By ALAN CHARLES GOOD
(Meat Inspector, Port of London Health Authority)

As the port health authorities in England and Wales are aware the Food Hygiene Regulations applicable to docks, etc., are in the process of detailed consideration at the Ministry. At the same time the existing Public Health (Imported Food) Regulations, 1937 are being reviewed and much thought is being given to the First Schedule with the intention of re-drafting it to bring it into line with present day meat practices.

Because every alteration of these Regulations must affect port health authorities wherever meat is imported, it should be profitable to consider some relevant observations leading to discussion of both Regulations, whereby differences of opinion and experiences may be resolved to mutual advantage.

It is proposed to deal with the problem under three main headings:

(i) Hygiene problems associated with the discharge of meats.
(ii) The examination of imported meats for condition and disease.
(iii) Conclusions arising out of the foregoing.

I. HYGIENE PROBLEMS ASSOCIATED WITH THE DISCHARGE OF MEATS

At this juncture it is necessary to consider which of the imported meats are "open foods." Some are clear examples, others are controversial, and there are those which are obviously not in either category.

Meat and offals are packed in a variety of ways—strong cartons, stockinette, stockinette and hessian, cans, pails, polythene and some combinations of selected pairs. Quite clearly, a substantial proportion of food so contained must be accepted as "closed food" and the hygienic problems of handling and storage are, therefore, considerably simplified. In the "open" and controversial groups, carcase meat occupies a prominent position, with frozen lamb and pork, together with much chilled beef, justifiably classified as "open food." There is, however, an increasing tendency to wrap chilled beef in a superior quality of stockinette and hessian outside covering which afford added protection from direct contact, although hessian may have disadvantages when considered from other viewpoints of hygienic wrapping.

Bearing this in mind, the issue becomes rather complicated if "open" and "closed" meats are carried in the same vessel — especially when in the same hold space.

Having made this point, consider next the hygienic handling problems concerned with "open meat."

(a) Before Arrival of the Vessel at Port of Discharge

No quayside should be considered suitable for a meat vessel to discharge its cargo unless a proper cleaning operation has been carried out. As must be expected, other cargoes leave their trails behind them; for example—chemicals, flour, hides, etc., and these can best be cleared with the hose and water. If this is done by pressure hose, incidental dirt, mud, etc., will be carried away from sunken crane and railway lines as well as crevices in the quay surface, leaving the quayside the more satisfactory for working. The quay should also be cleared of all superfluous materials, such as timber, empty containers and wrappings from previous vessels. The cleansing ought to be undertaken by the harbour authority as a routine responsibility, either directly or by arrangement with the shipping industry. Care should also be taken to restrict contamination of the meat from other cargoes, whether by contact, strong odour or dust particles.

(i) **Equipment**—That intended for use in discharging the vessel should be carefully examined prior to the vessel commencing work. The essential items of interest in this connection include, slings, tables, working boards and trucks.

Fig. 1. Loading a sling in ship's hold.

(ii) **Slings**—These ought to be properly kept and used specifically for the discharge of meat whenever possible. Exposed and absorbent fabric such as rope and canvas should be kept to a minimum, and this can be achieved by covering or substituting with aluminium alloy which is easy to clean.

(iii) **Tables**—These are used for sorting and will vary in size according to the meat being discharged. If they are constructed of wood, this should be of such quality that it can be kept in a clean condition. It is preferable that the table tops be covered with sheet metal to facilitate cleanliness. Aluminium alloys are suitable for this purpose—see British Standard 1470: 1955 NS4, NS5 and NS6. Unalloyed aluminium anodised in accordance with British standard 1615: 1958 has also given promising results.

(iv) **Sheets and working boards**—These are intended to provide a protective cover for the cargo and a working platform for the stevedores respectively as progress of the discharge continues in the ship's hold. They, also, should be properly maintained for these specific purposes.

(b) Arrival of the Vessel to be Discharged

Before discharge commences, care should be taken to remove any sawdust or debris on the surface of the plug hatches.

With the removal of the plug hatches in brine circulation ships it is usual for the engineer to shut the grid cocks before removing the hatch grids and, in doing so, to have a bucket to catch the draining brine from the grid, thus preventing any contamination of the meat cargo nearby. It is expected that he should have clean foot covering.

The stevedores discharging the vessel must be provided with clean foot coverings too, and it is very necessary to see that this covering is removed whenever a man comes out of the hold for any purpose, and for fresh coverings to be provided as frequently as necessary. While the purpose of the foot covering is to prevent contamination of the meat it is interesting to appreciate that,

from the viewpoint of the man working in the hold, the covering keeps his feet warm and prevents him slipping on the frozen surfaces. Expendable foot coverings should be considered, although practice suggests that clean hessian has its advantages.

It is important that coverings and working boards are brought into use immediately the stow permits, and this necessity may require close supervision.

The clothing of meat handlers is considered separately.

Fig. 2. "Sets" of meat on quayside.

(c) **On the Quay**

Meat is usually landed in a net or sling and which, when full, is called a "set." "Sets" of meat may vary in size, and trouble sometimes arises if large "sets" overflow from the slings when lowered on the truck or table and fall to the ground, which may not be as clean as desired.

While the discharge progresses a meat table may still have the residue of one "set" being sorted while the next "set" is being brought out of the ship's hold. Probably the best solution of this problem is to provide a low trestle or grating on which the last "set" can be detained clear of the ground before being lifted to the sorting table, so preventing contamination of the meat and ensuring that the sorting table is not overloaded to cause spillage.

(d) **Vehicles**

The standard required for road vehicles loading meat at the docks is described in the Ministry of Health, Food Hygiene Codes of Practice No. 2 "The Hygienic Transport and Handling of Meat." Vehicles falling short of this standard should be rejected as unfit for the purpose.

Cleanliness must always be a deciding factor and it would be an advantage to the industry if facilities were provided for cleaning rejected vehicles at the docks.

(e) **Straw**

Straw is in itself a harbourage of dust and dirt, and although various reasons are advanced that are intended to justify its use in meat vehicles, none of them can really satisfy those responsible for hygienic transportation of meat. There are indeed good reasons for its abolition from meat transports, because a clean and properly constructed container is quite sufficient alone.

(f) **Lighters**

Meat lighters are insulated and usually of special construction. A dressing of white paint or distemper to the external and internal surfaces respectively adds to suitability and appearance. In all respects of sanitation and hygiene, these craft must be maintained comparable with standards required of other transports and used specifically for meat if at all possible, although butter or lard need not be dogmatically excluded. Any craft not conforming to reasonable standard practice should be rejected outright. Where a cargo is not "closed food" it would be an advantage to provide clean gratings over the ceiling of the hold.

(g) **Personnel**

(i) **Clothing**—Added to the problem of deciding whether a particular consignment is "open food" there is an additional difficulty where the dock worker is assigned to meat loading or discharge for only a part of his day's work.

Where protective clothing is needed it must, therefore, be issued by the stevedoring company to those who are to be engaged on handling meat for that actual period of work. Suitable clothing may comprise porter's overall, shoulder covering and a washable head covering. The foot coverings have been considered already. Cotton gloves, inexpensive and readily replaceable may also be an advantage in certain circumstances.

(ii) **Personal hygiene**—Smoking—and of course spitting—are so obviously wrong that the evil of these habits need not be stressed. Unclean hands present a rather obstinate problem when contending with men who must remove hatch covers, plug hatches and beams from the hold, incidental to discharging the meat. Some thought has been given to the use of cream or paste cleansers followed by a rinse with clean water or wiped by a clean cloth or paper. Such a measure may prove unpopular among the men, and it is suggested that cotton gloves would be more acceptable, because a practice is already established whereby hand coverings are issued for special jobs, e.g., handling hides.

The clothing should be issued to all those engaged in the handling of the meat—from the hold, to the quay and into the distribution vehicles.

This aspect of the paper has been emphasised because it is of relatively great importance and that upon which there ought to be given particular thought when considering Food Hygiene Regulations appertaining to imported food.

II. THE EXAMINATION OF IMPORTED MEATS FOR CONDITION AND DISEASE

(a) **Examination for Condition**

This must be systematically implemented and extend from the ship's manifest of cargo on arrival, into the holds of storage and, thereafter, to cover the whole operation of discharge and delivery. Where "official certificates" are involved, these should be presented on the package conspicuously to facilitate the work of inspection. Any other practices should be supplementary to this obvious prerequisite if the operation of discharge is not to be impeded.

Judging the fitness of meat for human consumption at the port of entry is a responsibility to some extent dependent on experience and an intimate knowledge of the industry. Some conditions are evident without removal of wrappings, while all doubtful conclusions together with routine examinations necessitate complete exposure of the meat.

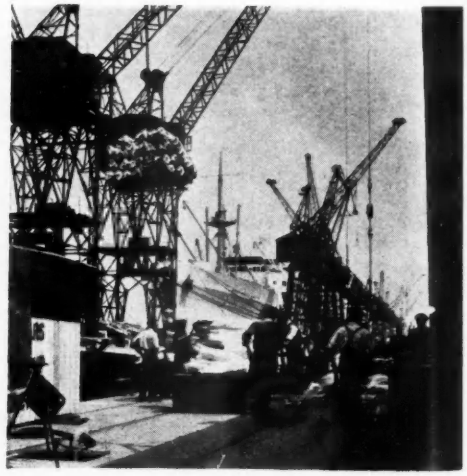


Fig. 3. "Sets" being sorted on meat table.

Conditions that attract the attention of the inspector include decomposition, mould growth, bacterial slime, icing, brine damage, water damage, vermin damage, taints, smoke and fire damage, the incidental damage or contamination in the course of being unloaded.

In the Port of London, meats thus affected are placed under detention at the dock store, trimming and further detailed examination can then take place under the

control of the port health cold store inspector, where facilities are provided to deal with any quantity of unsound meat. A competent butcher who is employed at this examination and reconditioning centre is responsible for the final wrapping and packing of all meat released by the inspector, and he satisfies the trade accordingly for direct sale or distribution.

Records for the past twelve months indicate the value of examination at this centre:

Carcases mutton and lamb	Quarters beef	Bags and carton boneless meats	Bags offal
47,652	306	356	5,676

Total weight condemned: 143 tons, 3 cwt., 2 qrs.

(b) **Examination for Disease**

It may not be fully appreciated that imported meats need examination for disease because "official certificates," affixed in the country of origin, certify that this has already been done by a competent authority. Experience in the Port of London, however, has shown that this is a very necessary control measure, and complete reliance on the face value of the "official certificates" could be quite misleading since the real value is liable to abuse. Control measures of any magnitude are not a reasonable proposition without proper facilities.

A properly constructed and equipped centre by a refrigerated store is essential. The equipment should provide for thawing, hanging, detailed examination, cutting, sawing weighing and packing. The nature and quality of materials overall needs no particular mention apart from being compatible with the best standards of hygiene and sanitation.

Such requirements may deter some port authorities from undertaking this control. Where facilities for detailed examination are lacking, a request that they be provided could be made in accordance with the provisions of the Imported Food Regulations part 2 (All Food) Para 7, sub para. 3.

It is clearly important that this type of examination should be a standardised part of the port health control where applicable in order to curb such incidents, e.g.:

(i) **Case A.**

Routine examination of beef livers. 12½% disease (Hydatid Cysts).

Country of origin and Ministry of Agriculture informed.

All beef livers from similar origin, many thousands of bags, detained on arrival.

Further examinations show varying degree of disease, as high as 17%.

Country of origin took measures to rid dogs of tapeworm.

Cow, bull and sheep livers banned from export.

Fig. 4. Meat under examination.

A gradual improvement took place over a period of four years.

Today incidence of disease slight.

(ii) **Case B.**

Routine examination of beef tongues.

Incision in blade revealed viable cyst. Confirmed under microscope as C. Bovis.

Country of origin informed and given details of method of inspection suitable for discovering this disease.

Systematic inspection of chilled beef carried out as a check.

(iii) **Case C.**

Routine examination of beef livers.

High incidence of telangiectasis. Lymph nodes often missing.

Country of origin and Ministry of Agriculture notified.

Packing establishments manager flown to this country.

Further consignments showing marked improvement.

(iv) **Case D.**

Examination of pigs heads.

5.7% diseased — no evidence of submaxillary lymph nodes having been incised.

Disease confirmed as tuberculosis and corynebacterium.

Entire importation of pigs from the same source detained.

Further examination showed varying incidence of disease from 5.7 to 14%.

Veterinary director flown to London.

Further shipments still under supervision.

These four cases indicate the danger of accepting the "official certificate" on face value and the value of an examination centre.

(c) **Bacteriological Control**

In extension of this control at the port, further investigation is necessary in conjunction with the Public Health Services Laboratory, especially in relation to meat and its connection with salmonella food poisoning outbreaks. To what extent imported meat and meat products are implicated is a matter of urgent concern, and, to this end, the Port of London Health Authority and the Public Health Service Laboratory at Colindale have continuous collaboration. Results of this team work are published in a joint report "Contamination of wholesale meat supplies with salmonellae and heat resistant Clostridium Welchii" by Betty C. Hobbs, D.Sc., Ph.D., and J. Greenwood Wilson, M.D., F.R.C.P., D.P.T.

III. CONCLUSIONS

The greater part of this paper has focussed attention on some matters that should be considered in relation to the forthcoming Food Hygiene Regulations appertaining to discharged food at the ports. It is suggested that a code of practice should be distributed for guidance to local authorities and the industry generally. Consultation on such a code between those concerned could enable the smooth implementation of the regulations when they come into force.

Obviously the problem of hygienic discharge of meats in the ports would be almost completely solved if it were possible to require that all meats must be adequately wrapped or packaged to prevent risk of contamination, a suggestion worthy of consideration.

Turning to the Imported Food Regulations, the problems of control are indeed complex. The types of meat brought into the country as a result of trade demands have made the existing regulations in many ways inadequate.

Horse and donkey meat with associated offals in considerable quantities now enter our ports and, while it is not implied that they are in any way undesirable, there is little power to deal with them unless they are found to be unfit for human consumption. These and other types of meat, some of them rather unfamiliar—such as reindeer and camel—ought to be subject to the same conditions of entry as "meat" presently defined, inspected and officially certificated. Thought should also be given to rabbit meat now entering this country from Australia and China. Some form of post-mortem examination should be a requirement even though ante-mortem examination may be impossible.

The expanding trade in boneless meats and meat cuts give rise to difficulties when interpreting the First Schedule. This schedule has been a powerful safeguard and is one which should be reconstructed to discourage methods of boning which are not acceptable and be more explicit in defining which lymph nodes should be always pre-

sent in cuts of meat and offals. Small cuts of meat—chops, steaks, legs of mutton and lamb, so trimmed that both fat and lymph nodes are removed, become involved. It may be claimed that such trimming is normal practice in the preparation of such cuts—the regulations again should specifically require the retention of lymph nodes associated with these cuts. Some offals arrived dressed in such a way that the associated lymph node is removed, e.g., short cut ox tongues, and here again it would be better from a control point of view if it was specifically stated that the associated lymph nodes must always be present—otherwise the tongues must be classified as "prohibited meat." The importance of this point is that the port inspector is able not only to satisfy himself that no disease is present, but also that a proper and satisfactory incision of the gland has been carried out.

Another trade not sufficiently controlled by legislation is that of imported meat for animal consumption. Meat and offals imported for animal feeding and often consigned to manufacturers of tinned animal food, may get into unscrupulous possession or into channels which cannot be supervised. From a public health point of view this trade is one requiring the closest supervision, and it would be reasonable to require that such meats should always be manifested as "not for human consumption" and marked as such. The port health authority should be notified of every consignment and the meat suitably sterilised prior to shipment.

Some exporting countries would welcome appropriate legislation on these lines to enable them to understand precisely the required standard with which they would willingly comply in order to maintain good trading relations and safeguard their national integrity.

In the light of what has been written, it may be possible to develop some greater measure of common appreciation and uniformity of practices at the ports, without which the national health could be jeopardised.

The volume and variety of meat imported for human and animal consumption tends to increase and become a more impressive responsibility in the port health service. Human health must be safeguarded at the ports, therefore, sufficient imaginative legislation is needed to support the good intentions of the experienced inspectors charged with the responsibility.

The Port of Agadir

Rehabilitation after Earthquake Damage

By M. R. BULL

For many hundreds of miles south of Agadir the flat coastline offers no safe anchorage and yet, despite the sheltered position of the bay of Agadir, the port was only opened in 1930. At first only used by the French navy to land supplies and troops for the conquest of southern Morocco, it was gradually fitted out for commercial use. The first wharf, constructed to the south of the town, was 450 metres long with an average depth alongside of 7 metres. In recent years, sea-going vessels were able to berth at a pier, 1,040 m. in length and equipped with a number of electric cranes of 6 tons capacity, and a floating crane of 24 tons capacity, the depth of water alongside being up to 9 m. There was good anchorage in the open roadstead where loading and discharging was carried out by lighters, and two tanker berths were also in operation.

During the French Protectorate of Morocco, Agadir grew from a small isolated town to a modern port of over 40,000 inhabitants. Although many French people left in 1956 when the country became independent, there were still some 36,000 people living in the port when on the night of February 29th, 1960, a violent earthquake wrecked three-quarters of the town and killed some 15,000 inhabitants. Today, the city is still a scene of desolation although demolition and clearance of the ruins are virtually completed. Many thousands of the poorer homeless are living in tents in three camps but plans are in hand to accommodate them, in time, in prefabricated buildings.

After the disaster, the port was the first to be cleared and reopened. It was given priority for two reasons. It is the only outlet for the citrus fruit and vegetable exports of the large Souss valley, and it was needed for the landing of the aid cargoes which were being sent to the stricken city from all over the world. Within a month, shipments were being made at the port although the earthquake had caused heavy damage. Cranes had toppled into the sea and sheds collapsed, electric light and water mains were disrupted and even the sea bed had altered, coming to within a few feet of the surface in certain places. Consequently, while the rubble was being cleared and the cranes righted, the harbour had to be charted again. Despite the difficulties, fruit and vegetable shipments through the port during 1960 increased by twenty thousand tons to a total of 85,000 tons.

The Port of Agadir was also an important fish canning centre. The sea off its coast is particularly abundant in fish, especially sardines. A fleet of 500 vesels, owned and manned by Portuguese, Spaniards and Moroccans, landed large catches which the factories canned or converted into fish meal for export. Although the fleet was at sea at the time of the earthquake, many of the fishermen's families were killed as their section of the city was

The Port of Agadir, South Morocco, before the earthquake of February 29th, 1960.

one of the worst hit. Afterwards the survivors were evacuated, many returning to their own countries. However, before many weeks had passed, the boats were fishing off Agadir once more, but landing their catches at more northern Moroccan ports. Today the fishing fleet is again using the port and three-quarters of the factories are working as usual.

Reconstruction Plans

As already mentioned, temporary repairs have been carried out where possible to the electric light cables, water pipes and drains. The rubble has been cleared and the badly damaged sheds demolished. Four large tents have been erected to provide covered storage for the fruit and vegetables awaiting shipment. A pontoon which had been towed to Casablanca for repairs is now back in use and four of the cranes are working.

(Continued at foot of following page)

Manufacturers' Announcements

The Marine Biogest

The Biogest is a compact unit for the complete disposal of crude sewage. It employs a mixed culture of aerobic bacteria, and other micro-organisms specially acclimatised to their diet, for the purification of crude sewage into an odourless innocuous effluent.

The Biogest was originally developed by the American Ship Building Company of Ohio, U.S.A., to abate sewage pollution from shipping in the Great Lakes of America. The opening of the new St. Lawrence Seaway permitting ocean going ships to enter the Great Lakes aggravated this pollution causing the U.S. Health Authorities great concern. Since these waters are a source of potable water supply to lakeside municipalities and other authorities, the Biogest attracted considerable attention from the U.S. Maritime Administration, the U.S. Public Health Service and the St. Lawrence Seaway Development Corporation. These bodies have now publicly given their official approval to the Biogest for shipboard use in the Great Lakes and during its first year of life, it has been installed on over a score of ships.

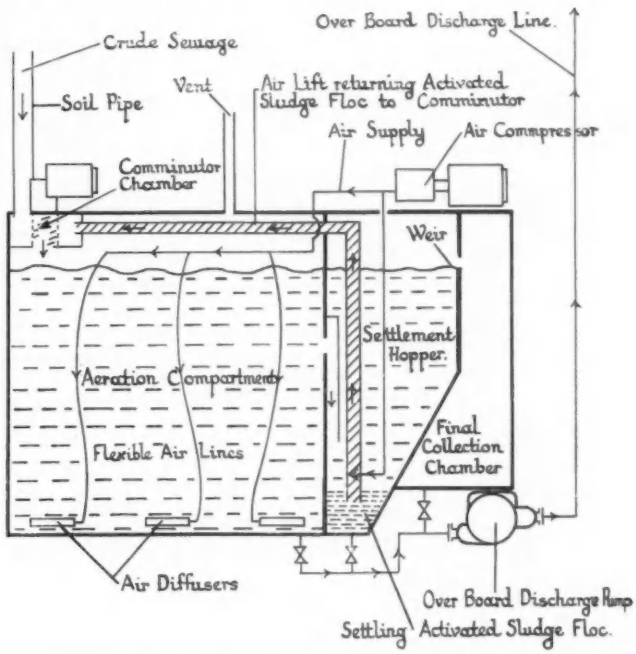
Since sewage pollution in British ports, estuaries, and coastal waters has become of major concern, hygienically and aesthetically, to the British people, the Biogest has aroused considerable interest. Many port authorities, ship owners, public health authorities, hospital boards etc., have expressed interest and, as a result, the Biogest has been further developed by Messrs. G. D. Peters and Co. Ltd., Slough, for all types of small-scale sewage flows.

In operation, crude sewage flows to the comminutor, the chamber of which is mounted within the top of the main tank. Within the comminutor the suspended solid matter present in the incoming sewage is reduced to particles of less than a ¼-in. diameter. At the same time the incoming sewage is mixed with the activated sludge floc (the general term for the purifying micro-organisms used in sewage treatment) returned from the settlement hopper.

The mixture of crude sewage and activated sludge floc passes into the aeration compartment of the main tank where the activated sludge floc oxidises the putrescible components with the aid of air. The air is supplied by an air compressor, mounted on top of the main tank, through special air diffusers in the aeration compartment.

The putrescible components that are in solution, e.g., detergents, disinfectants etc., are rapidly oxidised to stable harmless compounds, whilst those present as suspended solids, e.g., food particles, bacteria, etc. become incorporated into the activated sludge floc, which is continuously oxidised over a longer period of time.

The liquid level in the main tank is maintained by the spillage weir in the settlement hopper. As the mixture of activated sludge floc and now purified effluent flows into the settlement hopper separation takes place. The purified effluent spills over into the final collection chamber and the activated sludge floc settles to the bottom of the hopper, from where it is continuously transferred by the airlift return pipe to mix with the incoming sewage in the comminutor chamber, thus completing the cycle. The air for the airlift return is supplied by the air compressor.



Flow diagram to illustrate the operation of the Biogest.

When the level in the final collection chamber reaches a predetermined height a pressure switch operates the overboard discharge pump which empties the chamber overboard.

The operation of the Biogest is completely automatic and continuous. An important feature is the absence of septic tanks etc., and hence the complete absence of all offensive conditions.

The Port of Agadir—continued

Plans are in hand to effect considerable improvements to the port and work on these should commence in the near future. The existing carenage slip (cale de halage) is to be enlarged and in the meantime, temporary repairs will be carried out. The fishing port is also to be extended to accommodate a larger fleet. A large cold store is to be constructed to store the fish and an ice-producing factory will be built. More cranes are to be purchased for the port, some of them mobile, as well as other port equipment. The main 1,040 m. pier which was damaged at the sides will also require repair.

When the improvements have been completed, it will be possible to handle 130,000 tons of cargo or more.

Although no details have yet been announced, the Moroccan Government has said that donations from Morocco and abroad have totalled £1 million. Four thousand million Moroccan francs (£1=1400 M. frs.) have already been spent, but the total cost of rebuilding Agadir, including the eight hundred million Moroccan francs spent levelling the ruins, will come to some 24 thousand million francs. This includes the repairs to the port. To help meet this, the Moroccan Government imposed a tax of "national solidarity" which they estimate will bring in some 12 thousand million francs. Foreign loans are also to be raised and it is hoped to encourage foreign businesses to come to the new city.

Business Announcement

For some time past the Firestone Tyre and Rubber Co. Ltd. have been actively engaged in the production and supply of rubber fenders for ships and for dock and harbour installations. Recently they have been associated with Marine Craft Constructors Ltd., in a new development in the field of pneumatic fendering. Extensive trials have been carried out under the direction of Wg.-Cdr. Bennett Burleigh, Managing Director of Marine Craft Constructors Ltd., the final detailed work being undertaken by Firestone development engineers.

A new company has now been formed, the Firestone Burleigh Marine Pneumatic Fendering Co. Ltd., which will be engaged in the development and production of all types of marine rubber fendering including pneumatic. Directors of this company are Messrs. A. D. Wenzel, W. Young and Wg.-Cdr. Burleigh and the head office is on the Great West Road at Brentford, Middlesex.

Manufacturers' Announcements—continued

New Lighthouse Power Plant for Bull Point

Trinity House are re-equipping with modern plant many of the lighthouses around the coast of the British Isles. These include a number of the well-known names, such as Whitby, Flamborough, Souter, Anvil Point, Trevose, Hartland Point, etc.

Typical of these new installations is Bull Point on the North Devon Coast, guarding the entrance to the Bristol Channel. Until as recently as 1958, its lighting was supplied by oil lamps. The main lamp in the optic was an incandescent oil burner, with oil fed up to the burner by compressed air from a cylinder in the base of the tower. Now the oil has been replaced by mains electrical power with standby generating set, and the brilliant light of 800,000 candlepower is visible up to a distance of 18 nautical miles. Optic rotation, previously by means of a weight falling under gravity and requiring hand winding by the keeper every half-hour, is replaced by a duplicated electric motor drive. The fog signal twin siren was operated by a 24 b.h.p. paraffin oil engine driving an air compressor, and has now been replaced by a powerful twin diaphone fog signal, operated by compressed air from motor or diesel driven air compressor sets.

The sets were supplied to Trinity House by Petters Limited, and consist of an electric motor driven compressor set, with control cubicle; a diesel engine driven compressor set, with control cubicle, and an emergency 7·5 kVA generating set with control cubicle, which operates automatically on failure of mains supply.

Rapier 1520 Mobile Crane

Ransomes and Rapier Ltd., of Waterside Works, Ipswich, recently exhibited in Europe their new Rapier 1520 mobile crane. This 15-ton crane is designed for handling general cargo and is available with cantilever jibs up to 15.24 m. and strut jibs from 9.14 m. to 24.4 m. The longest jib can be lowered to the ground or raised without additional ballast, forward mast or other special equipment. Maximum prop loads are 15¾ tons with 13-ft. propping base or 17¼ tons with 10-ft. propping base; the maximum wheel loads with eight tons load are 10 tons on one steered wheel and 7½ tons on one driven wheel.

The strut jib is pivoted in brackets in the superstructure frame. Jib extensions can be provided, increasing the basic length of 30-ft. to lengths up to 80-ft. Telescopic stops are applied with strut jibs to limit inward over-derricking. The cantilever jib is pivoted at the apex of a steel-braced 'A' frame which is pin-jointed to brackets in the superstructure frame. Jib extensions can be provided to give higher lifts and greater radii.

APPOINTMENT VACANT

BELFAST HARBOUR COMMISSIONERS

The Belfast Harbour Commissioners invite applications for the position of Superintendent of Cranes and Weighbridges.

The person appointed will be responsible for the control, working and maintenance of the Board's cranes (capacities varying from 1½ to 200 tons) and weighbridges.

Applicants must not be more than 40 years of age and should have practical experience of crane operations and/or suitable technical qualifications, e.g., a University Degree or the Higher National Certificate in either Mechanical or Electrical Engineering. Supervisory and commercial experience would also be an advantage.

Commencing salary—£1,500 per annum, or commensurate with successful applicant's qualifications. Non-contributory pension scheme in operation.

Applications, stating age, qualifications, etc., together with the names of two references, must be addressed to the undersigned, endorsed "Superintendent of Cranes and Weighbridges," and delivered not later than TUESDAY, 6th JUNE, 1961.

The person appointed will be required to reside within or in the immediate vicinity of the City of Belfast.

Canvassing in any form, either direct or indirect, will disqualify.

Harbour Office, BELFAST, 1.

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